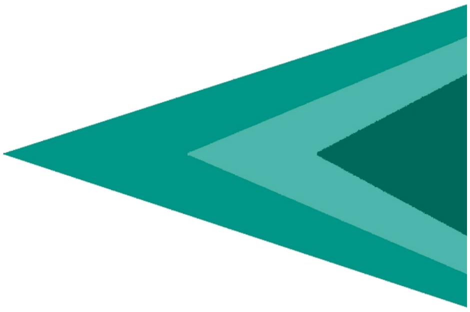
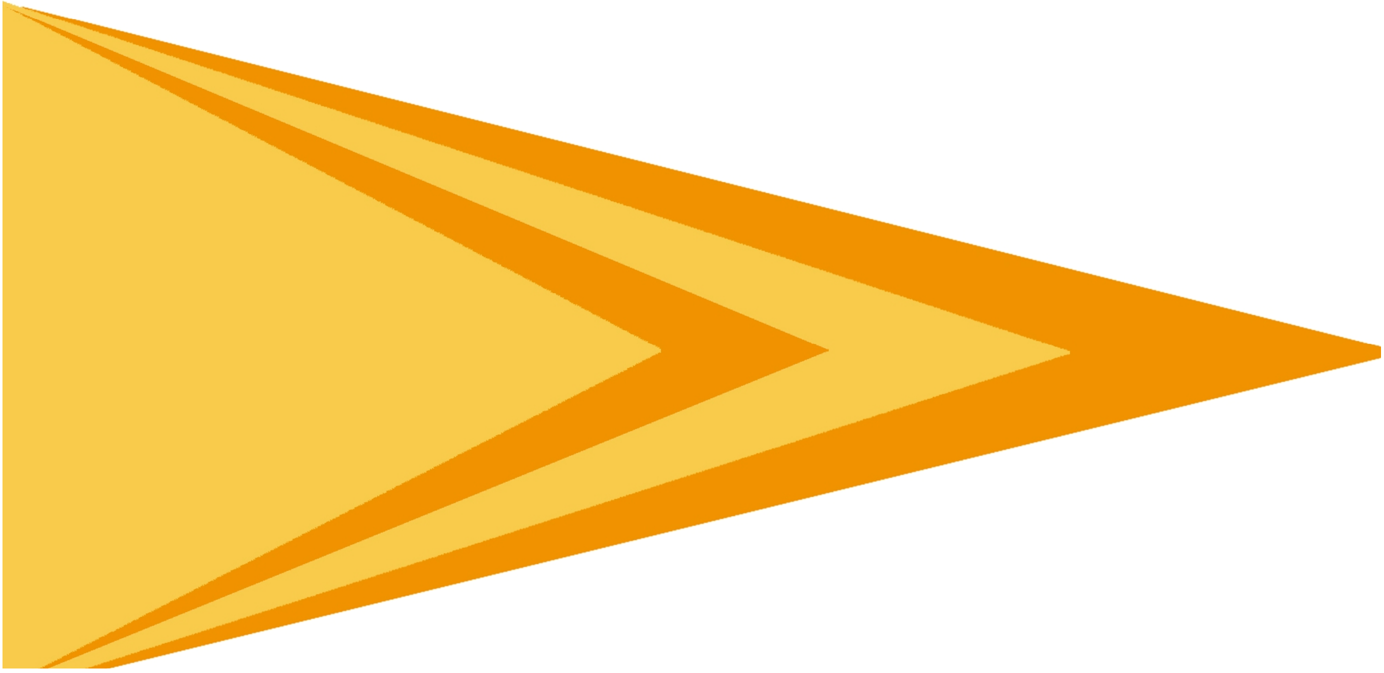


STATE-OF-THE-ART AND FUTURE PERSPECTIVES

Proceedings of the 1st International Baltic Symposium on Science and Technology Education (BalticSTE2015), Šiauliai, 15–18 June, 2015

Vincentas Lamanauskas,
Violeta Šlekienė, & Loreta Ragulienė (Eds.)



Vincentas Lamanauskas, Violeta Šlekienė, & Loreta Ragulienė (Eds.)

STATE-OF-THE-ART AND FUTURE PERSPECTIVES

Proceedings of the 1st International Baltic Symposium on
Science and Technology Education (BalticSTE2015),
Šiauliai, 15–18 June, 2015

SCIENTIA
SOCIALIS

2015

Vincentas Lamanauskas, Violeta Šlekienė, & Loreta Ragulienė (Eds.)

STATE-OF-THE-ART AND FUTURE PERSPECTIVES

Proceedings of the 1st International Baltic Symposium on Science and Technology Education (BalticSTE2015),
Šiauliai, 15–18 June, 2015

Reviewers:

Dr. Rita Makarskaitė-Petkevičienė
Dr. Milan Kubiatko

ISBN 978-609-95513-2-6

UDK 372.85(06)
St-112

Symposium Organizer

Šiauliai University, Natural Science Education Research Centre in cooperation with Scientific Methodical Center „Scientia Educologica“

Organizing Committee

Chairman

Prof. dr. Vincentas Lamanauskas, Šiauliai University & MMC „Scientia Educologica“, Lithuania

Members

Assoc. Prof. dr. Dalia Augienė, *Šiauliai University, Lithuania*
Dr. Renata Bilbokaitė, *Šiauliai University, Lithuania*
Dr. Erika Masiliauskienė, *Šiauliai University, Lithuania*
Dr. Laima Railienė, *Šiauliai University, Lithuania*
Judita Stankutė, *SMC „Scientia Educologica“, Lithuania*
Assoc. Prof. dr. Violeta Šlekienė, *NSERC of Šiauliai University, Lithuania*
Asoc. Prof. dr. Loreta Ragulienė, *NSERC of Šiauliai University, Lithuania*

Scientific Committee

Prof. dr. Boris Aberšek, *University of Maribor, Slovenia*
Prof. dr. Andris Broks, *University of Latvia, Latvia*
Dr. Paolo Bussotti, *Commission for the Publication of the National Edition of Federigo Enriques's Works, Italy*
Assoc. Prof. dr. Todar Lakhvich, *Belarusian State Medical University, Republic of Belarus*
Prof. dr. Vincentas Lamanauskas, *Šiauliai University, Lithuania*
Dr. Laima Railienė, *Šiauliai University, Lithuania*
Assoc. Prof. dr. Loreta Ragulienė, *Šiauliai University, Lithuania*
Dr. Uladzimir Slabin, *University of Oregon, USA*
Assoc. Prof. dr. Violeta Šlekienė, *Šiauliai University, Lithuania*

Symposium Sponsors

SMC „Scientia Educologica“
Scientia Socialis

ISBN 978-609-95513-2-6

© Scientia Socialis, 2015

The authors of the reports are responsible for the
scientific content and novelty of the symposium materials
All the papers published in the edition have been reviewed

Contents

Instead of an Introduction

NATURAL SCIENCE AND TECHNOLOGY EDUCATION: "RESETTING" MEANING
Vincentas Lamanauskas 7

Short Papers

MEDIA LITERACY SUPPORTING TEACHER´S EMPOWER DEVELOPMENT BY VIDEO PRODUCTION IN THE REPUBLIC OF MOZAMBIQUE
Agnaldo Arroio 11

THEORETICAL INVESTIGATION OF THE IMPLICATIONS OF COMPLEX SYSTEMS THEORY FOR TEACHING SCIENCE
Parvin Bazghandi, Saeid Zarghami-Hamrah, Yahya Ghaedi, Alireza Mahmudnia, Khosrow Bagheri Noaparast 14

THE 1ST YEAR STUDENTS' READINESS FOR STUDIES: THE CASE OF THE FACULTY OF BIOLOGY AT UNIVERSITY OF LATVIA
Rita Birzina, Dagnija Cedere 17

THE USEFULNESS OF PHYSICS FORMULAS IN THE OPINION OF STUDENTS. AN EYETRACKING STUDY
Władysław Blasiak, Pawel Kazubowski, Roman Rosiek, Miroslawa Sajka 20

A STUDY ON SCIENCE EDUCATION IN ITALY
Virginia Brianzoni, Liberato Cardellini 23

THE STUDY OF COMPUTATIONAL GEOMETRY IN THE SYSTEM *MATHEMATICA*
Aliya Bukusheva 27

WHAT LESSON OBSERVATION DATA REVEAL ABOUT THE CHANGES IN TEACHING SCIENCE: A CASE STUDY FROM LATVIA
Liga Cakane, Jelena Volkinsteine, Dace Namsone, Ilze France 30

COGNITIVE INTEREST: PROBLEMS AND SOLUTIONS IN THE ACQUISITION OF SCIENCE AND MATHEMATICS IN SCHOOLS OF LATVIA
Dagnija Cēdere, Inese Jurgena, Ineta Helmane, Inta Tiltiņa, Gunita Praulīte 33

THE DEVELOPMENT OF FACTORS AFFECTING THE USAGE OF EDUCATIONAL SOFTWARE IN CHEMISTRY EDUCATION IN THE CZECH REPUBLIC
Kateřina Chroustová, Martin Bílek 36

THE USE OF ICT IN THE SCIENCE LESSONS: EXPERIENCE FROM LATVIA
Inese Dudareva, Dace Namsone, Liga Cakane 39

FIRST STEPS IN ASSESSMENT OF STUDENTS' INQUIRY: A CASE STUDY OF NON-EXPERIENCED CHEMISTRY TEACHER
Karol Dudek, Paweł Bernard, Ewa Odrowąż 42

TRANSDISCIPLINARITY IN EDUCATION IS NEAR
Andrej Flogie, Kosta Dolenc, Boris Aberšek 45

SOME ASPECTS OF THE CONSTRUCTION OF THE THEMATIC TESTS FOR THE DIAGNOSIS OF COGNITIVE LEARNING OUTCOMES CHEMISTRY ENGINEERING STUDENTS
Liudmila Gorbunova 48

EXAMINING EFFECT OF ANIMATION APPLICATIONS ON STUDENT ACHIEVEMENT IN SCIENCE AND TECHNOLOGY COURSE
Sedat Yüksel, Mestan Boyaci 51

AN APPROACH TO TEACHING MEDICAL CHEMISTRY THAT HIGHLIGHTS INTERDISCIPLINARY NATURE OF SCIENCE
Aris Kaksis, Agnese Brangule, Mihails Halitovs 54

USAGE OF CRITICAL THINKING PRINCIPLES IN MEDICAL CHEMISTRY COURSE
Irina Kazuša 57

CONTENT LINES IN DESIGN OF CHEMICAL EDUCATION FOR WOULD-BE ENGINEERS
Vitali Khaletski 59

ONLINE SCIENCE LITERACY: TO TEACH OR NOT TO TEACH
Metka Kordigel Aberšek 63

STUDENTS' ATTITUDE REGARDING USE OF FRAYER MODEL IN THE DEVELOPMENT OF THE COMPREHENSION OF CHEMISTRY CONCEPTS
Silvija Kreile 65

THE ROLE OF GAME ELEMENTS IN CHEMISTRY ACQUIREMENT
Emilija Lesina, Sandra Kalnina 68

ACQUISITION OF SCIENTIFIC AND PEDAGOGY COMPETENCES BY PRIMARY PRE-SERVICE TEACHERS: MYTH OR REALITY?
Abdeljalil Métioui, Louis Trudel 70

A FLASH OF CONSTRUCTION SCHEMES COLLECTIVE IN THE CLASSROOM INVOLVING THE FIELD STRUCTURAL MOLECULAR
Marcelo Gouveia Nascimento, Gabriel Nicolas Garcia Alves, Marco Antonio Bueno Filho, Rodrigo Luiz Oliveira Rodrigues Cunha 74

EVALUATING THE POTENTIALS OF ICT INTEGRATION IN TEACHING WITH THE AIM OF INTENTIONALLY DEVELOPING COMPETENCIES FOR THE 21ST CENTURY IN PUPILS
Mateja Ploj Virtič, Kosta Dolenc 77

THE IMPLEMENTATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN SCHOOLS OF LATVIA
Juris Porozovs, Anita Migleniece, Daina Voita, Alvis Valdemiers 80

DISCUSSION OF VISUAL ATTENTION FOR SOLVING MULTIPLE CHOICE SCIENCE PROBLEM: AN EYE-TRACKING ANALYSIS
Miroslawa Sajka, Roman Rosiek 83

DESIGNING A BLENDED LEARNING ENVIRONMENT TO SUPPORT SELF-DIRECTED AND SELF-REGULATED LEARNING
Aysan Şentürk 87

THE ROLE AND SCOPE OF VISION THERAPY IN EDUCATIONAL PRACTICE
Violeta Šlekienė, Loreta Ragulienė 89

DEVELEPMENT OF COMPUTER-BASED EDUCATIONAL GAME ACROSS COMPUTER SCIENCE CURRICULUM
Dzintars Tomsons, Inta Znotiņa 92

DEVELOPMENT OF SCIENCE TEACHER CREATIVITY AND IBSE
Eva Trnova, Josef Trna 95

THE DISCUSSION AS A METHOD TO TEACH PHYSICS AT THE UNIVERSITY
Louis Trudel, Abdeljalil Métioui 98

INNOVATION SKILL DEVELOPMENT POTENTIAL OF TEACHING PROGRAMMING TO CHILDREN IN THE CONTEXT OF THE STEM EDUCATION
Adem Uzun 101

ON VOLUME OF THE ANTIPRISM IN CUBE AS A COMPLEX MATHEMATICAL PROBLEM
Lukáš Vízek 104

CHEMISTRY OF PAINTINGS OR HOW TO INVOLVE 8-10 Y.O. CHILDREN FOR A TWO-HOUR SESSION WITHOUT BREAKS
Denis M. Zhilin, Marina Tokareva 108

KEYNOTE SPEAKERS 111

NATURAL SCIENCE AND TECHNOLOGY EDUCATION: “RESETTING” MEANING

Vincentas Lamanauskas
Šiauliai university, Lithuania
E-mail: v.lamanauskas@ef.su.lt

Natural science and technology education is an inseparable part of general education. It is obvious, that this process embraces a rather wide group of people, according to the age – from the birth till the completion of general education. It is a very important period, during which a certain natural science and technology education is acquired. It might seem that rather many scientific, methodical, didactic and other articles, books have been written, analyzing NSTE problems. On the other hand, NSTE process continues, (has to be continued) further on. Of course, speaking about university and other level studies, a further education is different both according to the size and length and the other parameters.

One does not intend here to discuss exhaustively natural science and technology problems. The purpose is a little bit different. For the first time in Lithuania, 1st International Baltic Symposium on Science and Technology Education (BalticSTE2015) is being organised. After Lithuanian Independence re-establishment in 1990 – it seems to be the first such thematic international science event. To tell the truth, regional IOSTE symposiums took place twice in Lithuania. As it is known, IOSTE is an international organisation, unifying the most active world scientists in this field. In 2007, in Siauliai University, the 6th IOSTE Central and Eastern Europe country symposium, the theme of which was “Science and Technology Education in Central and Eastern Europe: Past, Present and Perspectives” took place. After two years, i.e. in 2009, the 7th IOSTE Central and Eastern Europe country symposium “Development of Science and Technology Education in Central and Eastern Europe” was organised. That was a serious change for the better not only developing natural science and technology education ideas, but also a good opportunity to share the experience with the other country scientists, to introduce the Lithuanian experience. However, Baltic countries haven’t organised any bigger science event of such thematic up to now, which would expose and reveal the experience of this region. Over the latter decade, a tendency has been observed to organise regional science symposiums as a possibility to develop this field achievements. Similar symposiums are organised in Africa, Asia, Latin America and so on. One has to believe, that this symposium will be meaningful not only to the Baltic but also to the other country scientists and all the other interested in this important sphere. One has to acknowledge, that there exists certain stagnation. There are relatively not many actively and productively working natural science and technology education specialists in Baltic countries. For various reasons it is rather difficult to integrate into international science space. On the other hand, it has to be emphasized, that Lithuania as well as Latvia and Estonia have a unique experience which could be interesting at an international level. Therefore, an exhaustive accumulated experience analysis is necessary. As an example, one can mention natural science education methodological history, published in Latvia from 1974 to 1940 (Vaivode, 2010). Such solid publication hasn't been prepared in Lithuania up to now. The other rather controversial period for all three Baltic countries is soviet occupation which lasted up to the very 1990. One can think that natural science and technology education was particularly unified in the whole empire of that time, however, this wouldn't be fair. It is obvious, that this period is poorly analyzed. It has been already written earlier about the urgency of natural science and technology education history (Lamanauskas, 2013).

However, I gave the name to the article "resetting meaning". Why? I want to emphasize some, in my opinion, important things. As I have mentioned already, the importance of early natural science and technology education is unquestionable. As J. Siraj-Blatchford (2001) notices, learning science is not simply knowing about 'natural phenomenon'. The educators' role is very important. This is not only natural phenomena explanation to this age children. This is an early natural science and technology literacy formation. It is important to involve children in common research activity, educate their abilities in making various things, it is important to find an adequate way to integrate ICT and so on. As it has been mentioned, historic NSTE aspect is very important. It is useful to include historical stories of scientific and technological discovery. In this way, nature understanding is encouraged, which will be very important for the children in the future, especially learning natural science subjects deeper. During this period, some problems arise. One of them is that very often educators are not properly ready for early natural science and technology education. A firm attitude remains that natural science and technology education will be realized in a general or secondary general education school. At least, Lithuanian educational experience allows asserting this. With an early NSTE is closely linked and related adult education. I dare to assert, that this is also a rather forgotten sphere, which is not paid proper attention to up to now. Natural science and technology youth and adult education isn't less important than early NSTE. Isn't it, that through this, first of all, is encouraged creative society and innovation development and so on. It is obvious, that not only in a pre-school institution or in the other formal educational institution it is being educated. With the children associate their parents, grandparents and other adults. The researchers analyze this naming as "Intergenerational learning" (Jane, Robbins, 2007). This is also an educational environment. And here, adequate adults' natural science and technology literacy is very important as well. This can be understood as a kind of "bridge" between the early and late NSTE. Keeping an attitude that 21st century society is a lifelong learning society, this again becomes an unquestionable thing. And this in its own way requires "resetting": the attitudes, point of view, strategies and so on. Over the latter two-three decades, we have observed an obvious transition from ecological to environmental education and sustainable development education. This is a much wider understanding than just only ecological-environmental question raising or problem solving. Thus, it is important to strengthen the partnership of environmental specialists, pedagogues, parents and other adults, because joining their competencies, one can seek for society value attitude change, seeking respect for life, environment saving and environmental problem not only solving, but also prevention. Developing "bridge" concept, as joining children and adults, an important becomes family science and technology education. As the researchers accentuate, family science and technology education is defined as expanding science and technology knowledge and skills from the school to the home of students (Trna, Trnová, 2010). Also, one cannot forget that children and youth grow and develop in different environments. International scientific society much wider analyses so-called “street-science” (in order to teach simple things without complex materials).

And there is one more thing, which would be good at least in short to discuss, actualize. The “Resetting” meaning also lies in this, that we are “lost” in the labyrinths of various theories, approaches, positions, attitudes and so on. Looking systemically, it is obvious, that it possibly appears the other type of overcharging/resetting when a separate process does not function any more. Let’s take an elementary natural science example. How does electrical overcharging appear? One of the cases is when a lot of devices through power distribution unit are connected into a socket. Such analogy can inevitably be applied to education sphere. Lately, natural science and technology education experiences the abundance of various theories, strategies, techniques and didactic approaches. One can dare to assert, that educational practice basically stays behind and most often does not take over the newest educational idea. Thus, periodical audit is necessary about what has been done, which strategies and educational approaches are most effective at a given time and in the near future. This is a very hard and complex task.

Though natural science and technology education is reformed in Lithuania, however, the results are not very pleasing. An urgent task remains for the whole educational community, how to achieve that natural science and technology subjects were attractive to the pupils that they tried to relate their future career with natural sciences and technology. It is understandable, that only school is not capable to solve that complex task. The situation is determined by the country’s common political-economic and, of course, social situation. However, properly organised natural science and technology education in comprehensive school can significantly change the situation. The responsibility of the school is to develop not a specialised teaching of natural science and technology subjects at school, but a general one, that every pupil acquired an adequate for that time natural science and technology education (Lamanauskas, 2008).

Thus, I think and hope that this symposium will have a proper influence on natural science and technology education “resetting” or at least will present certain insights for critical reworking science and technology education praxis.

References

Jane, B., Robbins, J. (2007). Intergenerational learning: Grandparents teaching everyday concepts in science and technology. *Asia-Pacific Forum on Science Learning and Teaching*, *8* (1), Article 3. Retrieved from https://www.ied.edu.hk/apfslt/v8_issue1/jane/index.htm#con.

Lamanauskas, V. (2008). Gamtamokslinis ugdymas mokykloje - neatsiejama bendrojo ugdymo dalis / Science education at school - an inseparable part of general education. Kn.: *Gamtamokslinis ugdymas bendrojo lavinimo mokykloje - 2008* (XIV nacionalinės mokslinės-praktinės konferencijos straipsnių rinkinys, Utena, 2008m. balandžio mėn. 25-26 d.). Šiauliai, p. 5-8.

Lamanauskas, V. (2013). Gamtamokslinio ugdymo istorija: aktualumo aspektas [Natural science education history: Relevance aspect]. *Gamtamokslinis ugdymas / Natural Science Education*, *1* (36), 4-7.

Siraj-Blatchford, J. (2001). Emergent science and technology in the early years. Paper to be presented at the: *XXIII World Congress of OMEP*, Santiago Chile July 31st to 4th August 2001. Retrieved from http://www.327matters.org/Docs/omepabs.pdf.

Trna, J., Trnová, E. (2010). Family science and technology education as a new teaching and learning strategy for all including gifted students. In *XIV. IOSTE Symposium. Socio.-cultural and human values in science and technology education*. Ljubljana, Slovinsko: Institute for innovation and development of University of Ljubljana, 1143.-1149..

Vaivode, E. T. (2010). *Ievads dabaszinibu macibu metodikas vesture (1774-1940)*. Lielvarde.

MEDIA LITERACY SUPPORTING TEACHER´S EMPOWER DEVELOPMENT BY VIDEO PRODUCTION IN THE REPUBLIC OF MOZAMBIQUE

Agnaldo Arroio
University of São Paulo, São Paulo, Brazil
E-mail: agnaldoarroio@yahoo.com

Abstract

Media Literacy is recognized as an essential area to promote critical view for citizens, to promote a democratic society in which citizens are able to consume critically the mass media but also to express themselves by this media as producers. An educational program was designed to support teachers' empowerment in using different media into the classroom in The Republic of Mozambique. To collect data, a pre and post questionnaire were applied, interviews and the videos produced during the course. According to the results showed, the decentralization of pedagogical tools production was really important achievement from this educational program.

Key words: *media literacy, ICT, teacher education.*

Introduction

Science and Technology are in the present day the greatest factors in changing the way we live. They have also made the world very small so that we are no longer living in the confined world of our town, region or countries isolated from what is happening in the rest of the globe (Härnqvist & Burgen, 1997). In this sense, the media literacy is recognized as an essential area to promote critical view for citizens, to promote a democratic society in which citizens are able to consume critically and also to express themselves by this media as producers. Media literacy is an important part of education for this society, and it cannot be denied (UNESCO, 2010).

> "*Current advance in information technologies and propagation of new digital media and learning environments stipulate the increasing importance of media literacy, which is today recognized almost universally as one of the key competences in the educational system (UNESCO, 2010, p. 5).*"

Science education plays a very important role in broadening students' world outlook. The science classes always discuss real, concrete things and phenomena, which are a part of students' reality and even everyday life (Lamanauskas, 2003).

> *"Media literacy is the capacity to access, analyse and evaluate the power of the images, sounds and messages with which we are faced everyday and which play an important role in contemporary culture. It includes the individual capacity to communicate using the media competently (UNESCO, 2010, p. 5)."*

Bingimlas (2009) found, in a literature review, many advantages of using new technologies and several barriers to the successful integration of these technologies in teaching and learning classes. It was pointed out that “While new technologies can help teachers enhance their pedagogical practice, they can also assist students in their learning.” (p. 236).

Becta (2004) organized the barriers into categories: teacher-level barriers (individual), such as lack of confidence, lack of time and resistance to change and also in school-level barriers (institutional), such as lack of effective training in solving technical problems and also lack of access to resources. In the purpose of this study it will be discussed here the lack of effective training as the most frequently referred barrier in literature to the integration of new technologies in education, video in this case.

How the integration of new technologies can empower teachers in Health Education centres in the Republic of Mozambique?

Methodology of Research

To collect the data, a pre and post questionnaire, interviews and analysis of videos produced by teachers during the training, were applied. The data were analysed according to content analysis (Bardin, 1977). We chose this qualitative approach which according to Lüdke and André (1986) allowed us to use the natural setting as primary source data, i.e. the teacher enrolled in a training program to produce videos.

According to Bogdan and Biklen (1997), the use of interviews is the best approaching tool to study people that share a particular feature. What they share between them will be revealed when they talk about their perspectives rather than when they are watched during their activities.

Results of Research

According to some reports from teachers they start to recognize the importance of pedagogical training to use the equipment. In this case just a digital photo camera and a notebook are used to edit movies. It is clear that just to have access to computer can not improve the quality of education. It is necessary to improve the technical skills of teachers to support them in using the computer in a pedagogical approach in their contexts.

According to some videos it is possible to notice the local needs. In some videos it is presented a narrative about consuming polluted water, risk to drink water from river without any clean proceeding. It is clear that for this group of teachers, from the north of the country, the main problem is the focus of contamination of river water. It is not possible to keep the production process centralized into the ministry of health or to have a general material that is able to achieve all the diversity of the country.

To implement the ICT in health education it is necessary that teachers feel confident about the domain in using these tools. In this sense, the training developed with these teachers had presented positive results as it was pointed out by them. As it can be seen in some cases the community around the centre was involved in the video production.

Based on the outcomes we can observe a huge variety of themes, the videos produced reports, different realities. While in some provinces the main issues were about drinkable water in other was about some epidemic as diarrheal and cholera. It was pointed out they can recognize their local ethnical characteristics in these materials based on pictures and videos.

Another positive aspect is related to the costs of production. For Mozambique to produce pedagogical materials with low costs and more appropriate to their needs is an essential achievement. It also contributes in the planning, creating, imagining, executing, drowning, etc., by facing challenger situations related to the daily life, problem situations and the search of possible solutions. In this way these teachers are empowering to have autonomous practices.

Conclusions and Implications

According to these results it can be noticed, that videos supported by new technologies can be used to support teachers with some elements that provide interactive experiences for them. It is believed that the ICTs in health education are able to communicate content issues to the students or community in a motivational way. It is fundamental that the teacher investigates what the situations are that could create interest and how it can be worked and articulated to the scientific topics, because it becomes a convincement act by showing to the students other ways to dialog about the reality.

But it is clear that teachers should be empowered to produce their own pedagogical materials according to their real needs. On this way to promote their autonomy to prepare these materials seems to be really important. The teacher's autonomy was stimulated by the new technologies as a cultural tool to mediate the process of fiction creation. They must be able to communicate using new media based on video. These skills require practice, and thus, the health science curricula should provide opportunities for settings in which these skills can be enhanced by new technologies.

References

Bardin, L. (1977). *Análise de Conteúdo [Content analysis]*. Lisboa: Edições 70.

Bimgimlas, K. A. (2009). Barriers to the successful Integration of ICT in teaching and learning environments: Review of the literature. *Eurasia Journal of Mathematics & Technology Education*, *5* (3), 235-245

Bogdan, R., Biklen, S. (1994). *Investigação qualitativa em educação [Qualitative research in education]*. Porto: Porto Editora,

British Educational Communications and Technology Agency (Becta) (2004). *A review of the research literature on barriers to uptake of ICT by teachers*. [online] Available at <http://www.webarchive.nationalarchives.gov.uk> [Accessed January 30, 2012].

Härnqvist, K., & Burgen, A. (Eds.). (1997). *Growing up with Science: Developing early understanding of Science*. London: Jessica Kingsley Publishing.

Lamanauskas, V. (2003). *Natural science education in contemporary school*. Siauliai: Siauliai University Press, 514 p.

Tornero, J. M. P., Varis, T. (2010). *Media literacy and new humanism*. Paris: Institute for Information Technologies in Education - UNESCO.

THEORETICAL INVESTIGATION OF THE IMPLICATIONS OF COMPLEX SYSTEMS THEORY FOR TEACHING SCIENCE

Parvin Bazghandi, Saeid Zarghami-Hamrah,
Yahya Ghaedi, Alireza Mahmudnia
Kharazmi University, Tehran, Iran
E-mail: pbazghandi@gmail.com, zarghamii2005@yahoo.com,
yahyaghaedy@yahoo.com, alirezamahmmudnia@yahoo.com

Khosrow Bagheri Noaparast
Tehran University, Tehran, Iran
E-mail: kbagheri4@yahoo.com

Abstract

The present study seeks to investigate the implications of triple levels of the complex systems theory, as a theory about nature, science, and education, for teaching science. As one of these implications, we might refer to explaining the basic features of the natural events through non-linear and holistic methods in teaching science.

Key words: *complex systems theory, holistic approach, science teaching.*

Introduction

The late 20th century and the early 21st witnessed deep and wide changes and developments in achievements obtained in several scientific domains from biology, ecology, climatology, and economics to anthropology, psychology, management, medicine, and even military sciences. These changes and evolutions emerged as a reaction to the simplicity approach toward explaining the nature and different dimensions of the social life and in order to explain the real complexities of the natural and social systems.

These changes and evolutions have motivated the thinkers to theorize accordingly and suggest definitions and features for the theories under a variety of titles (for example, see Rescher, 1998; Hooker, 2011; Lewin, 1993; Wegener, 2005; Mason, 2008; Davis and Sumara, 2006; Khattar, 2009; Doll et al., 2005). However, Goldman (2007) recommends that the complex systems theory could be considered as a more appropriate term for naming this perspective and the relevant views.

In the study the questions to be addresses are that: what is the origin of the complex systems theory and how could this theory be applied in teaching science?

Methodology

The present study is conducted within a philosophical approach. Nonetheless, due to the diversity of the methodologies in the field of philosophy and the philosophy of education (Given, 2008; and Heyting, 2005), the method (or methods) employed must be selected according to the specific goal(s) that this study seeks to serve. Therefore, this study employs analytic and inductive method in order to infer the theoretical implications of the complex systems theory for teaching science.

Findings

With regard to the current literature, the complex systems theory could be employed on three levels: first, as a theory about nature, second, as a theory about science; and third, as a theory about education. These three levels could provide implications for teaching science and other relevant fields including the educational content, teaching, and learning.

On the first level, the characteristics of complex systems theory about nature, including: top-down character, non-linear interactions, emergence, irreversibility, self-organization, modularity, hierarchy, adaptation and bifurcation are explained. On the second level, as Mason (2008) suggests, the complex system theory has been primarily emerged and developed in physics, biology, chemistry, and economics. According to Davis and Sumara (2006), the root of complex systems theory could be sought in theories such as Complex adaptive systems in physics, Non-linear dynamic systems in mathematics, Dissipative structures in chemistry, Autopoietic systems in biology, and Organized complex systems in the field of information technology. This theory addresses the environments, organizations, or systems that are complex and include a variety of elements and factors with interrelations and interactions. These elements or factors might be the atoms, molecules, neurons, human factors, institutions, companies and etc. Consequently, the complex systems theory abandons the simple causal models, linear predictability, and the reductionist, and atomistic, approaches for understanding the phenomena. The complex systems theory replaces these approaches with organic, non-linear, and holistic approaches (Youngblood, 1997; Cilliers, 1998; Wheatle, 1999; cited in Morrison, 2006, p.1). Regarding the third level, Iannone (1995), for instance, suggests that the curriculum should be flexible, open, chaotic, indefinite, and unpredictable according to the complex system theory. He adds that such a curriculum should maintain the capacity for tension, anxiety, and problems.

Conclusion and Implications

The present study investigates the implications obtained from the triple levels of the complex system, as a theory about science, nature, and education, for teaching science. To mention some of the implications we might refer to explaining the basic features of the natural events such as top-down character, non-linear interactions, emergence, irreversibility, self-organization, modularity, hierarchy, adaptation, and bifurcation. Other implications include uncertainty and employing the non-linear and holistic approaches and methods in teaching science.

References

Davis, B., Sumara, D. (2006). *Complexity & education: Inquiries into learning, teaching & research*. London: Lawrence Erlbaum Associates.

Doll, W. E., Leener, M. J., Trueit, D., Julien, J. H. (2005). *Chaos, complexity, curriculum & culture: A conversation*. New York: Peter Lang.

Given, L. M. (2008). *The Sage encyclopedia of qualitative research methods* (Ed). London: Sage.

Goldman, S. L. (2007). Systems, chaos, and self-organization. In *Great scientific ideas that changed the world* (pp. 62-78). Virginia: The teaching company.

Heyting, F. (2005). Methodological traditions in philosophy of education. In F. Heyting, D. Lenzen, J. White, (Eds.), *Methods in philosophy of education*. London & New York: Routledge.

Hooker, C. (2011). *Philosophy of complex systems*. New York: Elsevier.

Iannone, R. (1995). Chaos theory and its implications for curriculum and teaching. *Journal of Education*, *115* (4), 541-547.

Lewin, R. (1993). *Complexity: Life on the age*. London: Phoenix.

Khattar, R. (2009). *Pedagogy of complex relationality exploring complexity theory, neuro-phenomenology, and attentiveness for education* (Ph.D. Thesis). York University, Toronto, Ontario.

Maso, M. (2008). *Complexity theory and the philosophy of education*. New York: Wiley & Blackwell.

Morrison, K. (2006). Educational philosophy and the challenge of complexity theory. *Educational Philosophy and Theory*, *40* (1), 19-34.

Rescher, N. (1998). *Complexity: A philosophical overview*. Transaction Publishers, New Brunswick (U.S.A) and London (U.K).

Wegener, I. (2005). *Complexity theory: Exploring the limits of efficient algorithms*. Berlin: Springer.

THE 1ST YEAR STUDENTS' READINESS FOR STUDIES: THE CASE OF THE FACULTY OF BIOLOGY AT UNIVERSITY OF LATVIA

Rita Birzina, Dagnija Cedere
University of Latvia, Riga, Latvia
E-mail: rita.birzina@lu.lv, dagnija.cedere@lu.lv

Abstract

The present article reveals the first year students' readiness for studies in the context of three learning dimensions: content, incentive and interaction. The research was conducted during the implementation of first year study courses of the Bachelor programme at the Faculty of Biology of the University of Latvia. The qualitative data were obtained from students' answers to open questions related to their conceptions of learning and factors, which influenced their readiness for studies at the Faculty of Biology.

The gained results showed that students' readiness for studies correlates with their science background content knowledge, their previous learning experience, which depends on the teacher and the motivation to learn.

Key words: *case study, learning dimension, readiness to study*.

Introduction

The rapid changes in the modern world demand a new look at the essence of higher education. Research proves that young people starting their studies lack critical scientific understanding (Huber, 2010). School and university can be viewed as two different systems that differ with their style of working, the role of the teacher/university teacher and relations with the pupils or students (Raue, Schröder, 2014). The sharp decrease in the number of students has lately created additional problems in Latvia therefore less prepared students find themselves in higher education institutions. This results in the fact that great differences as regards the prior knowledge and learning skills are observed in the first year of studies, which hinders considerably the implementation of a unified study process. Many first year students are unable to adapt to studying in higher education institutions. This study year approximately 9% of the future biologists dropped the faculty already during the first semester. In order to ensure productive studies at the Faculty of Biology it is important to find out reasons why students fail to cope with the study objectives. The following research questions were put forward:

- How do 1st year students assess their readiness for studies at the Faculty of Biology?
- Which factors during the school years have helped to make the adjustment to the study environment easy?
- Which factors during school years have created obstacles for getting ready for studies in the higher education institution?

Methodology of Research

The present research was conducted during the implementation of study courses: Chemistry (Ķīmi2004, Part B) in December, 2014 and Introduction into Studies (Biol1190, Part C) in February, 2015 at the Faculty of Biology, University of Latvia. The sample comprised the first year students of the Bachelor programme: 35 students of the course Introduction into Studies and 27 students of the course Chemistry. Students were divided into 6 groups (Table 1) according to the school final examination assessment in biology and chemistry.

The students answered open questions related to their conceptions of learning and factors, which influenced their readiness for studies at the Faculty of Biology.

Table 1. A set of groups according to the school final examination assessment in biology and chemistry.

	Group_1B	Group_2B	Group_3B	Group_1C	Group_2C	Group_3C
Assessment	9-10	8	7	9-10	8	5-7
Number of students	14	17	4	5	11	11
Total			N=35			N=27

The qualitative data were obtained from students' answers. A coding system by identifying three types of codes – speaker, profile and contextual (Huber & Gurtel, 2013) was developed for processing of data. Contextual codes performed on the theoretical basis of Illeris's (2007, 2009) three dimensions of learning: Cognitive (knowledge, understanding and skills), Emotional (volition, feelings and motivation), and Social (types of interaction).

The program AQUAD 7.0 was used for processing of qualitative data.

Results of Research

In order to explore how students understand their own readiness for studies their answers were analysed. It was determined as the frequencies of codes describing students' views of what learning was, how ready they were to study, and what factors affected their readiness for studies.

Most of respondents consider that learning is a process linked with the acquisition and perfection of knowledge and understanding, which requires skills for individual work, application of knowledge and memorising. The learning is important for self-development but it takes time and effort.

As regards previous knowledge the students of groups with higher assessments (1B, 2B and 3B) considered their knowledge sufficient for the acquisition of biology and chemistry (1C). The data show that the situation is critical regarding the acquisition of chemistry, especially in the group 3C with a lower score. Respondents of groups 1B, 2B and 3B consider that the main factors for successful studies are their motivation linked with interest to biology and career, their purposeful attitude and like of biology as well as cooperation with teachers in school. Considering students' views on factors that have affected negatively their studies are mentioned: poor cooperation with teachers (especially Group 1C, 2C, and 3C), previous negative experience of learning in school (Group 2C and 3C) and untargeted personal action due to laziness and unwillingness to learn chemistry (particularly Group 3C).

Conclusions and Implications

The following conclusions based on the theoretical findings and obtained data can be drawn.

1. Prior knowledge gained at school testifies about student's readiness for the studies. Students who have had higher assessment in final examinations have expressed interest in biology during the school years and have learned it additionally; they have sufficient knowledge in biology to start successfully their studies at the Faculty of Biology. The problem is that during the first year studies students also have to acquire chemistry, physics and mathematics and part of the students have poor prior knowledge in these subjects. It is especially problematic for students who have had lower assessment in chemistry at school (5-7 points).

2. Key factors that determine successful studies according to respondents' views are their personal interest related to their liking of learning biology as their chosen speciality as well as purposeful action already during the school years acquiring biology additionally, participating in the subject Olympiads. Students also emphasize the teacher's role that is able to captivate pupils with his/her personal example, interesting lessons and practical activities.

3. Factors hindering the studies include, firstly, unsuccessful learning experience (equipment necessary for laboratory works is insufficient, lessons are uninteresting or are not delivered due to the lack of the teacher, etc.). Secondly, the attitude to learning-pupils often had been lazy to learn because learning requires a certain use of time and effort; it concerns more seriously the acquisition of those subjects that pupils do not like. It is interesting that one of the negative factors is also the communication with classmates who had been unwilling to learn biology and chemistry therefore there had been discipline problems in the class.

References

Huber, G. L., Gürtler, L. (2013). *AQUAD 7. Manual: the analysis of qualitative data.* GNU General Public License: Softwarevertrieb Günter Huber, Tübingen, Germany.

Huber, L. (2010). Anfangen zu Studieren. Einige Erinnerungen zur „Studieneingangsphase". *Das Hochschulwesen, 58* (4/5), 113-120.

Illeris, K. (2007). *How we learn: Learning and non-learning in school and beyond*. London / New York: Routledge.

Illeris, K. (2009). A comprehensive understanding of human learning. In book: *Contemporary theories of learning: learning theorists — in their own Words*. London / New York: Routledge.

Noteikumi par valsts akadēmiskās izglītības standartu/ Regulations on the Standard of national academic education/ (2002). LR MK 2002. gada 3. janvāra noteikumi Nr. 2. (In Latvian).

Raue, C., Schröder, C. (2014). Das Orientierungsstudium MINTgrün: flankierter Systemübertritt von Schule uz Hochschule. *Zeitschrift für Hochschulentwicklung*, *9* (5), 179-199.

THE USEFULNESS OF PHYSICS FORMULAS IN THE OPINION OF STUDENTS: AN EYETRACKING STUDY

Władysław Blasiak, Pawel Kazubowski,
Roman Rosiek, Miroslawa Sajka
Pedagogical University of Cracow, Poland
E-mail: wblasiak@up.krakow.pl, msajka@up.krakow.pl

Abstract

For the purpose of this work, 16-year-old students gave their opinions on the usefulness of physics formulas from the school curriculum. The average students regarded below 30% of the presented formulas as useful, whereas for winners of a physics competition it was over 60%.
Using the SMI Hi-Speed1250 eyetracker, a relationship between 52 students' eye fixation times on 16 presented formulas and their opinion on the formulas' usefulness was designated. For the best students, the Pearson correlation coefficient was close to zero. For average students, it was 0.6.
Key words: *physics formulas, public schools, school curriculum.*

Introduction

In the initial phase of learning, students are strongly interested in issues regarding physics (Blasiak, 2012). In further phases (i.e. lower high school) their interest in physics at school unfortunately experiences a sharp drop. One of the reasons is the difficulties students face in using the universal language of mathematics. Many students regard the mathematical view of physics as a substantial barrier and as a source of problems in understanding this subject. A physics formula is incomprehensible without an in-depth analysis and interpretation of the symbols included in mathematical equalities representing physical quantities or laws, which makes it seem useless to the student. Considering acquired knowledge as useless is a demotivating factor towards learning. The main objective of this work was identifying the opinions of students regarding the usefulness of physics formulas chosen from the school curriculum. For a deeper understanding of the brain mechanism of the students' decision-making, an eyetracking analysis of their eye activity during the assessment of the usefulness of selected physics formulas was carried out. The work posed the following questions. Which physics formulas contained in the school curriculum are regarded by the students as the most useful, and which ones are regarded as useless in everyday life? Are there any, and if so, what are the differences between assessments made by very good and average students? What is the relationship between the time spent looking at a given formula and the likelihood or recognising it as useful?

Methodology of research

Fifty two 16-year-old students who were finishing up their third year in lower high school in Poland took part in the eyetracking experiment. Thirty four of them were assembled into a group of average students from public schools with average achievements at a national level (ordinary students), and 18 of them were in a group of the best physics students who were the finalists of a physics competition at voivodeship level in 2014 (the best students). During the course of the experiment, the students were asked to pick out from a set of 16 formulas shown on a screen those that, in their opinion, were going to be useful in their lives. The eye-tracker measured the parameters of the fixations and saccades of the subjects at a frequency of 500 Hz.

Results of Research

Figure 1 depicts the percentage of both the students who were the finalists of a physics competition at voivodeship level as well as the average students who considered the formulas shown on-screen as useful.

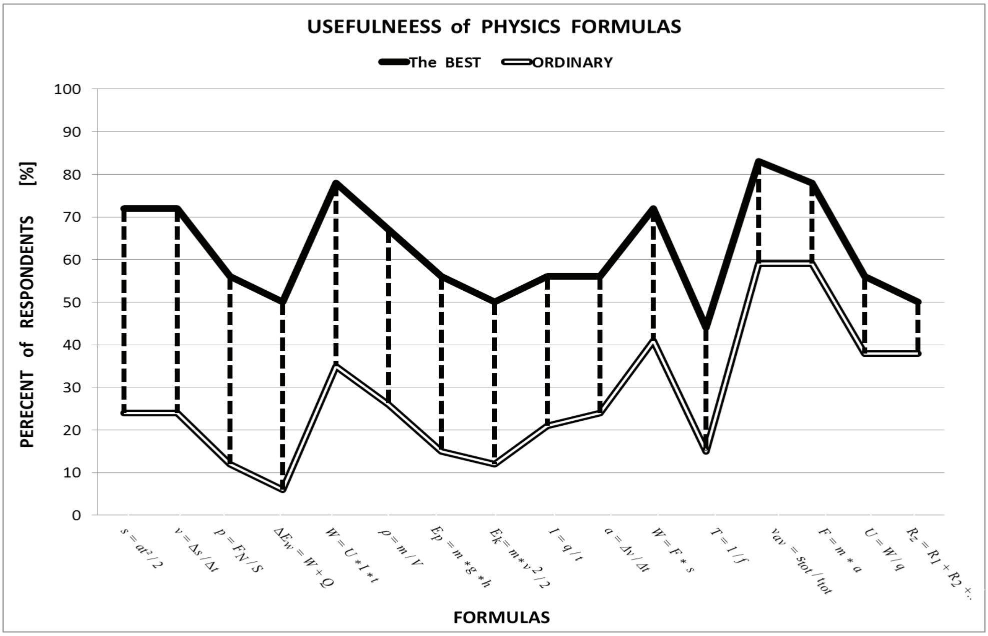


Figure 1: The percentage of students considering a given formula as useful.

The correlation between the total eye fixation time of the subjects on a given formula and their assessment of its usefulness (for the percentage of students which determined the given formula as useful) was determined. No statistically significant correlation was observed in students who were the finalists of a physics competition at voivodeship level. A statistically significant correlation was discovered in the case of ordinary students.

Conclusions and Implications

The physics competition finalists determined above 60% of the 16 formulas to be useful. For average students it was below 30%. The physics competition finalists determined the formula of constant speed of motion and Newton’s second law of motion as the most useful. The least useful was the second law of thermodynamics.

This study made use of new techniques allowing tracking of eyes of the subjects during their decision-making process. The analysis of the relationship between the number of eye fixations on a given formula and the number of formulas chosen as useful gave the most interesting result. The duration of individual fixations did not exceed several hundred milliseconds. For average students who are only slightly interested in physics, a positive correlation was observed ($R = 0.6$). The formulas which were being looked at for a longer time were chosen more often. For the physics competition finalists, the correlation was close to zero. The better-prepared students did not solely take the visual aspect of the mathematical form of the physics formulas into account, drawing also from experience regarding their usefulness.

Analysing the usefulness of school curriculum, physics formulas from the students’ point of view, incline for the improvement of the methodology of teaching mathematical description of natural phenomena. In today’s fast paced world we must still strive to perfect realisation of the rule: “Non scholae, sed vitae discimus”.

References

Blasiak, W., Godlewska, M., Wcislo, D., Rosiek, R. (2012). Spectrum of physics comprehension. *European Journal of Physics*, *33* (3), 565 – 571.

A STUDY ON SCIENCE EDUCATION IN ITALY

Virginia Brianzoni, Liberato Cardellini
Marche Polytechnic University, Ancona, Italy
E-mail: l.cardellini@univpm.it

Abstract

Within the European Project "PROFILES", a study on science education has been carried out. The opinion of different stakeholders has been taken into account and in Italy almost 200 participants have answered questionnaire concerning several aspects of teaching. The results have shown that scientific literacy should be based mainly on the development of communication skills/personality and on the improvement of intellectual skills. The study has highlighted that approaches judged more effective are not really common in the current educational panorama.

Key words: *inquiry-based science, science education, PROFILES.*

Introduction

The Università Politecnica delle Marche (UNIVPM, Italy) is one of the partners of the PROFILES, European project. PROFILES (Professional Reflection-Oriented Focus on Inquiry Learning and Education through Science) is funded by the 7th Framework Programme of the European Commission (http://www.profiles-project.eu/) and involves 21 institutions of 19 different countries. The project promotes inquiry-based science education (IBSE) (Bolte et al., 2012) and aims to increase teachers' competence and to enhance scientific literacy of students, encouraging new approaches in science teaching. Nowadays, students are not really interested in the science (Schreiner & Sjøberg, 2004). Lecture method, in which an oral presentation is exposed to learners, is still the primary one. The efficacy of other new teaching methods (e.g. cooperative learning, problem solving) is widely proved but they are little applied. PROFILES, aims to overcome these matters, promoting an "education through science" (Holbrook & Rannikmae, 2007). The final purpose of the project is just to make the learning of science subjects more interesting and meaningful. According to these aims, it is important to take into account the opinions of different stakeholders, considering stakeholder any person or organization with an interest in the education being offered in a school. For this reason, all PROFILES partners have participated in a Study on Science Education, collecting and analyzing their stakeholders' views about science (Bolte, 2008; Osborne et al., 2003). The main purpose of this study is to answer the following question: "*Which aspects of science education do you consider meaningful and pedagogically desirable for the individual in the society of today and in the near future?*" (Schulte & Bolte, 2012). In the following parts some of the main results of the study on science education, carried out in Italy, will be presented.

Methodology of Research

The study has been divided into three rounds. Stakeholders have given their opinions about aspects, pedagogically considered more relevant, on which science teaching should be based. Initially, in the 1st round, 927 participants were asked (in digital or in printed format) to answer three open questions and to formulate their statements about: situations, contexts or motives where scientific literacy is useful; fields of science that are considered significant and which the individual should have dealt with; qualifications that are to attain. Despite more than 900 participants have been involved, the final sample of the first round was composed of 173 stakeholders, divided into four groups as follows: 44 students; 59 university students; 28 science teachers; 42 scientists. The participants' answers have been classified in 88 categories. In the 2nd round the same participants that took part in the 1st round have been invited to answer additional questions, in order to further assess the categories previously identified. In particular, the following questions have been asked: "which priority should the respective aspects have in Italian science education (priority)?" and "to what extent are the respective aspects realized in current Italian science education (practice)?". These two questions have been answered with reference to each category according to a six-tier scale, ranged from 1 to 6. In the 2nd round participants have been invited to further combine the categories judged more important. Thanks to the support of PROFILES project coordinator (Freie Universität Berlin (FUB)–Germany) the categories' combinations have been processed through hierarchical cluster analyses in order to identify, for each aspect of science education, the 1st five categories judged more relevant. The hierarchical cluster analysis has allowed us to identify also three concepts concerning different suggestions about desirable scientific literacy. These concepts have been assessed in the 3rd and final round. In particular, participants have been asked to assess the priority of the three concepts and their realization in practice, according to a six-tier scale, as done in the 2nd round.

Results of Research

At the end of the 1st round several categories regarding aspects of desirable science education have been established. In particular, according to the participants' comments (both teachers and students) the experimental activity is judged as a priority. Laboratory activity is considered an effective educational tool for helping learners to better understand phenomena and concepts. At the same time, also students' interests, connections to everyday life and to natural phenomena, as well as the teamwork, appear to be helpful to stimulate students' curiosity in educational process. Regarding the qualification that students should develop, participants have given several statements and their opinions are rather heterogeneous. According to science teachers, scientists and university students, comprehension and understanding skills should certainly be improved, but while science teachers consider that students should also improve their capacity of reasoning, for scientists is more important to capture the interest and curiosity of learners. This data dispersion is probably due to the uncertain role of the school in contemporary society. Everybody seems to agree that it is necessary to act and to change, but the way forward is not clear yet. It is evident that the teachers' professional preparation is a key issue: as has been pointed out "teachers are key players to renew science education" (Rocard, 2011, p. vii). With reference to the desirable methodical aspects, cooperative learning is judged a powerful teaching tool, because it involves students to achieve a common goal and to interact with each other. Several studies have shown that, if correctly applied, the cooperative learning encourages students to learn significantly more and better and allows them to have a deeper understanding (Slavin, 1995). In the 2nd and 3th rounds participants have combined the previously identified categories according to two different views: "priorities" and "practice". The obtained results have shown a big gap between priority and practice of the main categories of desired science education. Indeed, in the opinion of participants, none of the most important categories is sufficiently practiced in schools, especially the experimental activity. The study has highlighted that in Italian school students' interest should increase and issues related to everyday life should be more dealt with.

Conclusions

The study on science education has shown that, in Italy, students' interest and motivation should be enhanced, as well as the experimental activity and connections to natural phenomena and everyday life. Also, the teamwork has a key role in students' engagement and it should be more encouraged. Surely, there are some critical aspects of science teaching in Italian schools and obviously there is not an ideal prescription, but teachers play a central role and their enthusiasm is what makes the difference. Teachers can be as a barrier to any change initiative, or they can be the authors of effective teaching, motivating students to critical thinking. PROFILES project provides a philosophy: any improvement in teaching and learning comes through a professionally prepared teacher. This is the reason why the project supports the professional development program. There is a path that can be taken to enhance scientific literacy. PROFILES project encourages also the use of interesting teaching-learning materials that, starting from socio-scientific issues, make science education more relevant and increase students' intrinsic motivation (some teaching-learning materials in Italian language are available at: http://www.profiles.univpm.it/).

References

Bolte, C., Holbrook, J., & Rauch, F. (2012). *Inquiry-based science education in Europe: Reflections from the PROFILES Project.* Available from http://www.profiles-project.eu/.

Bolte, C. (2008). A conceptual framework for the enhancement of popularity and relevance of science education for scientific literacy, based on stakeholders' views by means of a curricular delphi study in chemistry. *Science Education International, 19* (3), 331-350.

Holbrook, J., & Rannikmae, M. (2007). The nature of science education for enhancing scientific literacy. *International Journal of Science Education*, *29* (11), 1347-1362.

Osborne, J. F., Ratcliffe, M., Collins, S., Millar, R., & Dusch, R. (2003). What "Ideas-about-Science" should be taught in school science? A delphi study of the expert community. *Journal of Research in Science Teaching*, *40* (7), 692–720.

Rocard, M. (2011). Foreword. In de Vries M. J., van Keulen H., Peters S., & van der Molen J. W. (Eds.), *Professional Development for Primary Teachers in Science and Technology*. Rotterdam: Sense Publishers.

Schreiner, C., & Sjøberg, S. (2004). ROSE: The relevance of science education. Showing the seeds of ROSE. *Acta didactica*, *4*.

Schulte, T., & Bolte, C. (2012). European stakeholders views on inquiry-based science education. Method of and results from the international PROFILES curricular delphi study on science education round 1. In C. Bolte, J. Holbrook, & F. Rauch (Eds.), *Inquiry-based Science Education in Europe: Reflections from the PROFILES Project*. (pp. 42-51). Berlin: Freie Universität Berlin.

Slavin, R. E. (1995). *Cooperative learning. Theory, research and practice* (2nd ed.). Needham Heights, MA: Allin and Bacon.

THE STUDY OF COMPUTATIONAL GEOMETRY IN THE SYSTEM *MATHEMATICA*

Aliya Bukusheva
Saratov State University, Saratov, Russia
E-mail: bukusheva@gmail.com

Abstract

In the ninetieth Alfred Gray developed intensively applications of Mathematica to Euclidean differential geometry of curves and surfaces. He opened completely new approaches to differential geometry in teaching and research. Modern geometry uses the latest computer technology to solve their problems. Advanced mathematical computer programs allow using a fresh approach to the teaching of geometry in universities, taking into account the attraction of students to computers. The paper outlines some thoughts on teaching computational geometry.

Key words: *bachelor, computational geometry, wolfram mathematica*.

Introduction

The need for a modern course on computer geometry has become especially urgent in recent years. This is due to the fact that the computer methods are used extensively in modern geometry and its numerous applications (engineering, design, pattern recognition, etc.).

The Discipline “Computational geometry and geometric modeling” is absolutely new to the Saratov State University named after N.G. Chernyshevsky (SSU). This discipline has appeared because of the emergence of a new educational standard. Since 2011, the Mechanics and Mathematics Faculty of SSU has prepared students for Bachelor degree in the “Mathematics and Computer Science”.

The Discipline “Computational geometry and geometric modeling”- is essential and foundational according to the curriculum for Bachelors “Mathematics and Computer Science” in Saratov State University. The term of bachelors study is four years. This discipline is studied in the fourth year of study.

Methodology of Study

The purpose of the discipline “Computational geometry and geometric modeling” is the formation and development of students’ practical skills and modeling of geometric objects of creation with the help of information technology and computer technology.

The objectives of the discipline are: to study the mathematical apparatus necessary for geometric simulation; to master modern information and computer technology for imaging and modeling of geometrical objects; to get students acquainted with the basics of computer geometric simulation, that can make the job of mathematicians researchers, applied mathematicians and mathematics teachers significantly more effective.

As a result of studying this discipline a student should know ways of defining curves, surfaces, three-dimensional geometric objects and the basic methods of image in different environments, the main types of graphic image formats, visualization techniques for solving geometric and dynamic problems.

As a result of studying this discipline, the student should be able to create images of curves, surfaces, three-dimensional geometrical objects in different environments.

Results of Research

The discipline “Computational geometry and geometric modeling” is closely related to other disciplines that are included in the curriculum of bachelors. On the one hand, starting to study this discipline, students must already have basic knowledge of Geometry and Topology. Tasks that can be solved in the course of “Computational geometry and geometric modeling” suggest the students’ knowledge of the subject area, namely, a student must have good understanding of the basic geometrical figures, such as figures of the first and second orders, cones, cylinders, shapes, rotation, etc. A student must know about the basic invariants of curves and surfaces - curvature and torsion. On the other hand, during the course of “Computational geometry and geometric modeling” students not only master and understand the previously studied material better, but also learn absolutely new fundamental knowledge. Thus, for example, students are fluent at basic concepts of Lie groups and Algebra, but the problem being solved by them about classification of four-dimensional Lie Algebra creates fundamentally new ideas about the structure of finite-dimensional Lie Algebra.

Summary of the lectures. Smooth curves from a computational point of view. Splines and Bezier curves. Bezier surface. Projective (rational) Bezier curves. Beta-splines, curves and beta-beta-surface. Geometric modeling. Build on curves and surfaces. Methods of computer graphics.

The main software tool is supposed to be a package from Wolfram Research, Mathematica for practice. Numerous investigation carried out by various authors (see, for example, (Gray, Salomon, Abbena, 2006; Ivanov, Ilyutko, Nosovski, Tuzhilin, Fomenko, 2010; Salomon, 2006; Wolfram Demonstrations… 2015) and others) show that, Wolfram Mathematica allows to solve complex computational problems, to visualize various objects.

Summary of the practical classes: The first acquaintance with the package Mathematica; Basic operations package Mathematica, graphics, visualization depending on the parameter; Graphics: basic principles; Programming in the package Mathematica; Curves in computer geometry; Computed surface geometry; Tensor calculus on smooth manifolds; Computer graphics.

Students` extracurricular work is organized with the use of free software: Maxima, Scilab, GeoGebra.

Conclusions and Implications

Discipline “Computational geometry and geometric modeling” is a necessary foundation for further study and solution of applied mathematical problems and problems of geometric modeling. The use of computers in geometry does not only contribute to the visualization of geometric objects, but also allows us to solve new research problems. The use of modern mathematical software packages allows us to make learning of student more intuitive, geometric disciplines that are close to the practical problems, and to solve complex geometric problems, allowing a practical class to a new level.

References

Gray, A., Salomon, S., Abbena, E. (2006). Modern differential geometry of curves and surfaces with *Mathematica*. Third ed. CRC Press.

Ivanov, A. O., Ilyutko, D. P., Nosovski, G. V., Tuzhilin, A. A., Fomenko, A. T. (2010). *Computer geometry: Practice. Textbook*. Moscow, Binom Publ., Internet University of Information Technologies (In Russian).

Salomon, D. (2006). *Curves and surfaces for computer graphics*. Northridge: Springer.

Wolfram Demonstrations Project (2015). Retrieved from http://demonstrations.wolfram.com/.

WHAT LESSON OBSERVATION DATA REVEAL ABOUT THE CHANGES IN TEACHING SCIENCE: A CASE STUDY FROM LATVIA

Liga Cakane, Jelena Volkinsteine, Dace Namsone, Ilze France
University of Latvia, Riga, Latvia
E-mail: liga.cakane@lu.lv, gelena-v@inbox.lv, dace.namsone@lu.lv

Abstract

The improvement of teaching quality in Science subjects is closely connected to the implementation of reforms initiated in education policy resolutions in the school practice. It is crucial for teachers to implement the paradigm shift from transmitting information to 21st century learning design. It means to change not only teaching strategies but also their views what teaching is. Lesson observations were the main source to answer the research questions: What do lesson observations reveal about the students' learning in science lessons according to criteria selected? What information lesson observation gives about teachers' skills to organize learning according to changes envisaged in education policy resolutions?

Key words: *case study, lesson observation, science teaching and learning.*

Introduction

Government resolution (2006) undertaken in Latvia, set the direction towards promoting students` competencies (critical and analytical thinking, creativity, communication, collaboration, ICT etc.), continued in new education policy resolutions (2014). However, the changes specified in the policy resolutions can be incorporated in teacher's practice only if each teacher implements a paradigm shift from transmitting information to more student-centered 21st century learning design, which corresponds to the constructivist opinion about learning. For constructivist-oriented instruction (Cobern & Loving, 2008, Niaz, 2011 etc.) in the classroom is stressed: inquiry based learning, collaborative support, improvement of problem-solving and critical thinking, support to help students to construct mental models and experience conceptual change, use of technology, and impact of students and teachers' beliefs (Schraw et al., 2006). On the lesson level it means to set learning outcomes, to refresh students' experiences, to hook and to interest them, to offer cognitive and metacognitive strategies that are helpful for the knowledge construction, to provide feedback, etc. Hattie's research (2012) showed that learning to learn including clarity, challenging learning outcomes, the feedback to improve the performance, etc. has a significant impact on student learning.

To be clear, how the reforms set in governmental resolutions are actually implemented in the Science subjects classroom, the lesson observation and analysis were used. The lesson observation is a strong tool to have data not only about student learning but also about teachers' skills demonstrated. The use of classroom observation as a research tool has also had a long history (Roberson 1998, etc.) in the world context, but very little experience in Latvia. Teachers' performance is mostly measured by the traditional method summed up from students' performance which contradicts the changes in the education policy regulations.

The following criteria were set to observe students' learning: range of cognitive activity, collaboration and learning mode (outcomes, feedback). The criteria focused to teachers' skills: appropriate teaching methods, methods' techniques and the skills to organize professional collaboration between students.

This research poses the following questions: What do lesson observations reveal about the students' learning in science subject lessons according to criteria selected? What information lesson observation gives about teachers' skills to organize learning according to changes envisaged in education policy resolutions?

Methodology of Research

A total of 53 physics, chemistry, biology, science lessons were observed and analyzed from 9 schools representing all school types in 2013 (grades 5-12). The observations were carried out by specially trained experts from the Centre for Science and Mathematics Education, each with 10-15 years of experience. The experts used specially developed e-observation sheets for transcript and analysis. For the analysis the criteria were categorized: communication of learning outcomes and feedback, efficiency of teaching and learning strategies, cognitive development, collaboration. Each lesson was transcribed and then analyzed by each expert who observed the lesson using a Likert scale (0 – not present; 1 – minor presence; 2 – moderate presence; 3 – present) and confirmed the evaluation with comments according to the specified criteria. Experts' comments were coded. Content analysis was used. The numerical data were processed using R 3.1.2. software.

Results of Research

The results according to the categories show that mastering collaboration skills in acceptable level (2-3 in scale) was observed in 52% of the lesson; use of high order cognitive skills - only 19% of the lesson. The dominant description by experts of the study process characterizes the lessons as cognitive low. Clarity of learning outcome was in 50%, establishing the outcome - 41% of the lessons. However, the experts' reveal that while the teacher did receive information about students' learning, the teacher failed to communicate feedback that would help the students improve their performance.

The data about teachers' skills to organize learning according to the criteria – appropriateness of the methods used to achieve the goal, the technique of the methods and collaboration indicate that teachers skills in acceptable level are respectively in 54%, 47%, 38% of the lessons.

Conclusions and Implications

Research evidences the gap between the priorities described in the education policy resolutions from 2006 and the reality in the classroom in 2013. Analysis of the data reveals that extremely often teaching in the classroom is performed as transmitting information including separate elements of new learning aspects and leads to a conclusion that the change of teaching and learning paradigms has just begun. Science teachers successful in traditional teaching emphasized largely working on lower order cognitive skills. This corresponds to research which shows teachers may well be more comfortable with a traditional teaching mode (Olson, 2003) characterized historically for the East (Pavlova, Pitt, 2003).

In order to achieve real changes in the classroom is not enough to make changes in documents, there is the obvious need for teacher professional learning in a different mode. The previous research about chemistry teachers' skills in Latvia (Volkinsteine et al., 2014) pays attention to insufficient teachers' analyses and reflection skills. These skills are possible to improve through discussion, opinion exchange, practicing analyses, reflection about real learning situations in their own and their colleagues' practices. That allows the teachers themselves to see improvable aspects of teaching, to acquire learning as the concept modeling and learning through collaboration experience. A completely different form and essence is needed and this corresponds with the conclusions of another research (Fulan, 2011, etc.).

References

Cobern, W., Loving, C. (2008). An essay for educators: Epistemological realism really is common sense. *Science & Education, 17*, 425-447.

Fullan, M. (2011). Whole system reform for innovative teaching and learning. In ITL Research. *Innovative teaching and learning research: 2011 Findings and Implications* (pp.30-39). Retrieved from http://www.itlresearch.com/research-a-reports/2011-itl-research-findings

Hattie, J. (2012). *Visible learning for teachers. Maximizing impact of learning*. London and New York: Routledge.

Niaz, M. (2011). *Innovating science teacher education. A History and philosophy of Science perspective.* New York and London: Routledge.

Olson, J. (2003). School technology education: The search for authenticity. In: E.W. Jenkins (Eds.), *Innovations in science and technology education.* Vol. VIII. Paris: UNESCO Publishing.

Pavlova, M., Pitt, J. (2003). Technology education in the Russian Federation: Is the perspective clear? In: E.W. Jenkins (Eds.), *Innovations in Science and Technology Education.* Vol. VIII. Paris: UNESCO Publishing.

Roberson, T. J. (1998). Classroom observation: Issues regarding validity and reliability. Paper presented at the annual meeting of the Mid-South Education Research Association, 6 November, in New Orleans, LA.

Schraw, G., Crippen, K. J., & Hartley, K. (2006). Promoting self-regulation in science education: Metacognition as part of a broader perspective on learning. *Research in Science Education*, *36*, 111-139.

Volkinsteine, J., Namsone, D., Cakane, L. (2014). Latvian chemistry teachers' skills to organize student scientific inquiry. *Problems of education in the 21st Century*, *59*, 86 – 98.

COGNITIVE INTEREST: PROBLEMS AND SOLUTIONS IN THE ACQUISITION OF SCIENCE AND MATHEMATICS IN SCHOOLS OF LATVIA

Dagnija Cēdere, Inese Jurgena, Ineta Helmane,
Inta Tiltiņa, Gunita Praulīte
Riga Teacher Training and Educational Management Academy, Riga, Latvia
E-mail: dagnija.cedere@lu.lv, ineta.helmane@rpiva.lv, gunita.praulite@rpiva.lv

Abstract

The low level of pupils' knowledge and skills in science and mathematics is a serious problem in the economic development of the country. Cognitive interest is a crucial learning motive; no successful learning process is possible without inciting interest. Grade 9 pupils were surveyed to find out the respondents' cognitive interest in the field of exact sciences. On average the interest in subjects of exact sciences is poorly pronounced. Respondents have good understanding about the causal relations while the cognitive activity, the skill to overcome difficulties in learning is low. Cognitive interest in learning is promoted by diverse methodological approaches that are oriented towards pupils' self-actualization and purposefulness.

Key words: *cognitive interest, learning process, science and mathematics*.

Introduction

One of the essential factors hindering the growth of the society's wellbeing is pupils' insufficient science literacy. The lack of knowledge and skills in science and mathematics today can be considered a threat to the modern science and technologies- driven economy (European Commission, 2012).

Mathematics and science education are in a state of change (Roth & Verschaffel, 2007). The pupil's desire to learn or the cognitive interest that develops in the interaction of the significance of the object (values), will experience importance in the learning process. Highly developed cognitive interest is expressed as the willingness to delve in the essence of the phenomena, the understanding of causal relations, independence and enthusiasm in learning and endeavours to overcome the difficulties oneself (Щукина, 1971, Čehlova, 2002). Research proves that pupils have insufficient interest in science (Potvin & Hasni, 2014; Cedere, Gedrovics, Bilek, & Mozeika, 2014); however, the issue about which and to what extent pupils' cognitive interest in science subjects is expressed is little researched. In order to understand how to solve this long-drawn problem about the lack of young people's cognitive interest in science and mathematics the following research questions were put forward:

- Do Grade 9 pupils like the science lessons (biology, chemistry, and physics) and mathematics?

- To what extent is pupil's cognitive interest expressed in science subjects? Have science and mathematics encouraged pupils to become enthusiastic and persistent in attaining their aims?

Methodology of Research

A survey in which Grade 9 pupils from different regions of Latvia participated was conducted. The total number of respondents is 237; 57% of respondents are girls and 43% boys. The questionnaire comprises 66 closed questions where the answers correspond to the Lickert scale of four values and are coded: 1 – no, 2 – rather no, 3 – rather yes, 4 – yes. The questions in the questionnaire are grouped in four parts. This study analyzes pupils' answers to 32 questions that are included in two parts of the questionnaire: 1) Mark the answer which best describes your interest in science subjects (biology, chemistry or physics) and mathematics! 2) Do you want to explore science and mathematics?

Excel and SPSS programmes were used in data processing.

Results of Research

Respondents' answers testify that pupils' interest in science subjects is not high. The question *Do you think with pleasure about the lessons of biology/chemistry/physics/mathematics?* was answered positively about biology by 27.4% of the respondents, about chemistry – 22.4%, about physics – 21.1% and about mathematics – only by 14,8% of the respondents. The mean values of answers M ($1 \leq M \leq 4$) prove that on average Grade 9 pupils like biology lessons the most, although the mean value in this subject is $M = 3$, which corresponds to the value judgment *rather like* (not *like*), in other subjects $M < 3$ and in physics even $M < 2.5$. Thus pupils rather do not like physics lessons (Figure 1).

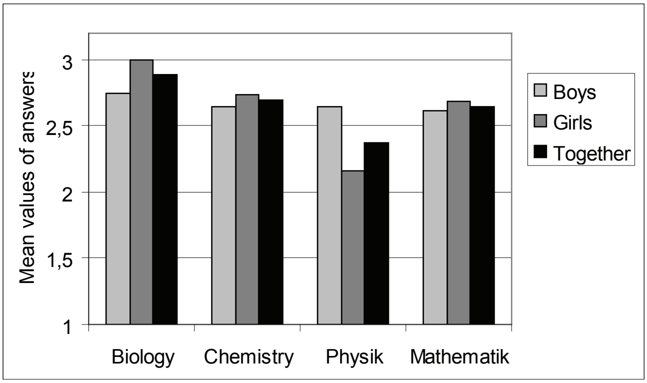


Figure 1: Science lessons in pupils' evaluation; mean values of answers ($1 \leq M \leq 4$).

Several criteria were used to define the cognitive interest: purposefulness, independence, intensity and stability of cognition, the connectedness between the cognition and professional disposition. The questions are grouped according to the criteria. Respondents' cognitive interest on the whole can be assessed as average on the scale of three levels; however, the quantitative indicators have a wide dispersion. On average pupils possess the skill to bring out the causal relations of phenomena and events and to ground them. The willingness to overcome the learning difficulties, to choose tasks with higher degree of difficulty is less pronounced. There are no statistically significant differences between the girls and boys as regards the purposefulness and intensity of cognition in science subjects.

Conclusions and Implications

The study shows that on the whole the respondents' cognitive interest in science and mathematics can be assessed as average; however it differs considerably for particular pupils and is of a wide range. The fact that there are rather many pupils who have explicitly low interest about the science subjects included in study attracts the attention. Boys' interest in chemistry, physics and mathematics is higher than that of the girls; girls, in their turn, have greater interest in biology.

Pupils' answers express the understanding about causal relations as a principle and the readiness to explain different phenomena, to find out their causes, to predict the possible solutions of the problem related to the nature and energy resources in the future. However, pupils have rather low intensity of the cognition in science subjects.

The results of the study confirm the truth that a successful learning process can not be imagined without stimulating the interest (Gudjons, 1998, 250, Geidžs, Berliners, 1998, 309-310). Nowadays the national standards of education and methodological guidelines in science and mathematics do not emphasize specifically that teachers in their work have to pay attention to the differences of pupils' interests and abilities. Opinions expressed by respondents allow concluding that in order to promote higher cognitive interest, teachers have to use diverse teaching approaches, tasks of higher difficulty level thus actualizing pupils' needs for self-actualization and the aim (the pupil is motivated by acquainting him/her with the possible achievement).

References

European Commission, EACEA, & Eurydice (2002). Developing Key Competences at School in Europe: Challenges and Opportunities for Policy. Eurydice Report. Luxembourg: Publications Office of the European Union. Retrieved March 02, 2015 from: http://eacea.ec.europa.eu/education/eurydice/

Roth, W. M., & Verschaffel, L. (Ed.) (2007). New directions in mathematics and science education. In: *Great Ideas in Science Education, 9*.

Čehlova, Z. (2002). *Izziņas aktivitāte mācībās* [Cognitive activity in learning]. Rīga: RaKa.

Potvin, P., Hasni, A. (2014). Interest, motivation and attitude towards science and technology at K-12 levels: A systematic review of 12 years of educational research. Retrieved March 02, 2015 from: http://dx.doi.org/10.1080/03057267.2014.881626.

Cedere, D., Gedrovics, J., Bilek, M., Mozeika, D. (2014). Changes of 15 years old students' interest in science in Latvia: 2003-2013. *Proceedings of the 9th IOSTE Symposium for Central and Eastern Europe „Science and Technology Education for the 21st Century"*, September 15-17, 2014, Hradec Králové, Czech Republic, pp. 103-112.

Щукина, Г. И. (1971). *Проблема познавательного интереса в педагогике* [Problem of cognitive interest in pedagogy]. Москва: Педагогика.

THE DEVELOPMENT OF FACTORS AFFECTING THE USAGE OF EDUCATIONAL SOFTWARE IN CHEMISTRY EDUCATION IN THE CZECH REPUBLIC

Kateřina Chroustová, Martin Bílek
University of Hradec Králové, Hradec Králové, Czech Republic
E-mail: katerina.chroustova@uhk.cz, martin.bilek@uhk.cz

Abstract

Why don´t we encounter too regularly with the inclusion of educational software in chemistry education in the Czech Republic? What factors affect the usage of educational software? What kind of relationship can be identified between these factors? For the search of answers to those formulated questions was necessary to, first of all, carry out a deep analysis of the conditions that could lead to more effective usage of educational software in chemistry education. In this article, we analyse the factors that affect the usage of educational software in chemistry education with the application of the unified theory of acceptance and use of technology (UTAUT) and the related theories, including a comparison of our results with the results of realized research studies with a similar theme.

Key words: *educational software, chemistry education, the unified theory of use and acceptance of technology (UTAUT).*

Introduction

Although the latest information and communication technologies are increasingly being integrated to schools, the extensions of educational software to the basic equipment of schools is not so common. Thus the usage of educational software in lessons is becoming rather an additional marginal matter, although it has the potential to facilitate certain aspects of education, whether it is a visualization of the curriculum, interactivity or individualisation of education. However, this potential cannot be fully developed if teachers will not accept the educational software as an equal source of curriculum presentation and will not use it. This of course depends on the acceptance and the use of ICT in education in general. On this topic a number of studies was accomplished, both about the acceptance of ICT in general, e.g. Martinovic, Zhang (2012), Valtonen et al. (2015) as well as on the acceptance of specific technologies, e.g. tablets (Ifenthaler, Schweinbenz, 2013) or interactive whiteboards (Tosuntaş, Karadağ, Orhan, 2015). Knowledge of factors affecting the use and acceptance of educational software is an integral part of the search for reasons, whether and, if so, when and why is the usage of this software more successful than lessons without its use.

Theoretical Background

We use so called “the unified theory of acceptance and use of technology (UTAUT)” to describe the factors influencing the acceptance and use of educational software. This theory was designed by Venkatesh et al. (2003) and it was built on a combination of the eight previous theories about the acceptance and the motivation for the usage of technology with the purpose to create a unified theory. This theory was based on the unification of these theories: theory of reasoned action (TRA), technology acceptance model (TAM), motivational model (MM), theory of planned behaviour (TPM), a combined theory of planned behavior/technology acceptance model (C-TPB-TAM), model of personal computer use (MPCU), diffusion of innovations theory (IDT), and social cognitive theory (SCT). The UTAUT theory identifies four basic determinants of behavioural intention towards the acceptance of information technology: performance expectancy, effort expectancy, social Influence and facilitating conditions that are influenced by gender, age, experience, and voluntariness of use.

Purpose of Overview Research Study

In view of the fact that the Czech Republic still has a lack of research studies dealing with identifying the acceptance and use of educational software in specific educational situations, the goal of our research is to create a model of the interaction of factors influencing the acceptance and the use of educational software by teachers of chemistry as the general subjects based on the analysis of the results of other similar studies, e.g. Donnelly, McGarr, O’Reilly, 2011, Prestridge, 2012, Hernández-Ramos, et al., 2014. The model includes the attitudes of teachers towards educational software and ICT in general, the impact of their gender, age, experience with the use of educational software and ICT, length of professional experience, etc.

Methodology of Research

The creation of the model consists in identifying the factors that influence the acceptance and the use of educational software based on UTAUT and their relationships. Based on the theoretical analysis of these nine theories, a model of the impact of these factors on the acceptance and the use of educational software for teachers of chemistry as the general subjects in the Czech Republic is originated. On its basis a research tool for the verification of this model in practice will be prepared in the form of a questionnaire.

Conclusions

If we know the factors and the extent of their influence on the acceptance and the use of educational software in chemistry education, we will know how we can lend support to the usage of educational software in the classroom. Due to the development of technologies, expanding of the usage of educational software is more than required. Based on the analysis of these factors and their empirical verification, the optimal conditions will lead to more effective use of educational software in chemistry education and to the development of methodologies with recommendations for the teachers and students of how to integrate educational software in chemistry education and how to use it should be identified.

Acknowledgements

This paper is published thanks to the financial support of the project of Specific Research of Faculty of Science University of Hradec Králové Nr. 2102/2015.

References

Venkatesh, V., Morris, M. G., Davis, G. B., & Davis, F. D. (2003). User acceptance of information technology: Toward a unified view. *MIS quarterly*, *27* (3), 425-478.

Tosuntaş, Ş. B., Karadağ, E., & Orhan, S (2015). The factors affecting acceptance and use of interactive whiteboard within the scope of FATIH project: A structural equation model based on the Unified Theory of acceptance and use of technology. *Computers & Education*, *81* (February 2015), 169-178.

Ifenthaler, D., & Schweinbenz V. (2013). The acceptance of Tablet-PCs in classroom instruction: The teachers' perspectives. *Computers in Human Behavior*, *29* (3), 525–534.

Valtonen, T., Kukkonen, J., Kontkanen, S., Sormunen, K., Dillon, P., & Sointu, E. (2015). The impact of authentic learning experiences with ICT on pre-service teachers' intentions to use ICT for teaching and learning. *Computers & Education*, *81* (February 2015), 49-58.

Martinovic, D., & Zhang, Z. (2012). Situating ICT in the teacher education program: Overcoming challenges, fulfilling expectations. *Teaching and Teacher Education*, *28* (3), 461-469.

Hernández-Ramos, J. P., Martínez-Abad, F., Peñalvo, F. J. G., García, M. E. H., & Rodríguez-Conde, M. J. (2014). Teachers' attitude regarding the use of ICT. A factor reliability and validity study. *Computers in Human Behavior*, *31*, 509-516.

Donnelly, D., McGarr, O., & O'Reilly, J. (2011). A framework for teachers' integration of ICT into their classroom practice. *Computers & Education*, *57* (2), 1469-1483.

Prestridge, S. (2012). The beliefs behind the teacher that influences their ICT practices. *Computers & education*, *58* (1), 449-458.

THE USE OF ICT IN THE SCIENCE LESSONS: EXPERIENCE FROM LATVIA

Inese Dudareva, Dace Namsone, Liga Cakane
University of Latvia, Riga, Latvia
E-mail: inese.dudareva@lu.lv, dace.namsone@lu.lv, liga.cakane@lu.lv

Abstract

The implementation of key competences in primary and secondary school education demanded the changes in the Science teaching practice in Latvia. The first research was initiated during the piloting the new curriculum in science and mathematics (2009 – 2011). Lesson observations were the main source of answers to the research: what ICT tools are used by teachers and students in science subjects? What information it gives to us for teachers CPD?

Key words: *lesson observation, ICT, teachers CPD needs.*

Introduction

In many European countries, reforms in science education have taken place related to OECD PISA outcomes. Government resolution (2006) undertaken in Latvia, set the direction towards promoting students` competencies, continued in new state education policy resolutions (2014). The aspects of competencies in science subjects' content were incorporated as aspirations to perform scientific inquiry (France, 2010), to create a link with real life and to implement the effective use of information technologies (ICT).

The key of reform implementation in classroom practice is the teacher. The usage of ICT promotes improving of students' learning outcomes only when the teacher has the knowledge about the efficient and meaningful use of ICT in teaching/learning process (Ertmer & Ottenbreit-Leftwitch, 2010). Teachers can develop their professional competence in the use of ICT not from books, but in practical use of technology in the context of the subject (Duran, Brunvand & Fossum, 2009).

The main ICT usage areas for learning Science subjects in Latvia schools are multimedia, tools for the experimentation with ICT in Science lab, Internet as a tool for learning and collaboration and subjects' specific software. The interactive set of e- materials prepared in a systemic way, according to the school curriculum coordinated in all Science subjects is available on the Internet for every student. The multimedia materials help students to create the connection between symbols, objects and processes in sciences (Mayer, Chanler, 2001).

Based on the science teachers' professional development needs of the study findings, it can be concluded that the prerequisites for effective integration of ICT in the teaching/learning process is the availability of ICT equipment, the support materials in a native language and corresponding in-service training, which must be focused not only on the acquisition of ICT skills, but also on the methodology of ICT usage in teaching/learning process. It will take time to bring the usage of ICT on the level where it will really influence the students' achievements - from the introduction of ICT in schools and increasing teachers' professional competence to real impact on students' achievements (Cambell, Martin, 2010).

Our previous research showed the teachers' way of regular ICT usage in the classroom (Dudareva & others 2011) from the usage of basic to specific ICT skills in the classroom. This research is looking for answers about the real situation in school practice before the new curriculum reform occurs. The aim of this research is to find the answers to the following questions: Is ICT used in the Science subjects teaching and learning process? What ICT tools are used by teachers and students? What information it gives to and for teachers CPD? Lesson observation indicates whether the reforms are actually implemented in the classroom or whether they are still outside the door.

Methodology of Research

The data were collected by the group of experts working in the Centre for Science and Mathematics Education of Latvia University. The experts observed 64 science subject (Physics, Biology and Physics) lessons from 2012 to 2015, grades 7-12. The experts used specially developed e-observation sheet for transcript and analysis. The usage of information communication technologies was set as the criteria for this research. Each lesson was transcribed by each expert who observed the lesson according to the specified criteria using Likert scale (0 – not present; 1 – minor presence; 2 – moderate presence; 3 – present). The numerical data were processed using R.3.1.2. software. Comments were coded. Content analysis used.

Results of Research

The research is ongoing. The processed results show that ICT is used in Science subjects (Physics, Biology and Physics) lessons in 78% of cases. Computer with multimedia projector and interactive whiteboard are mostly used ICT tools for teachers to demonstrate images, tasks, solutions, etc. 42 % of the lessons indicated the ICT usage demonstrated by teachers on an unacceptable level (0 or 1 in Likert scale). The description by experts of the observed study process characterizes the use of ICT as inefficient in many cases: *the presentation with more than 30 slides; the teacher uses self prepared teaching material, but the images are unclear; presentation is required, but the problem is how it is used; tasks are formulated unclear, low efficiency of the process observed.*

Only 22% of cases, ICT are used by students and computer is mostly used ICT tool for students.

Conclusions and Implications

Analyses of the data acquired during the lesson observation reveal that quite frequently teachers use the ICT for demonstration of tasks, pictures and task solutions, as well as they often don`t offer the students tasks and problems which must be solved by using ICT. It corresponds to (Campbell & Martin, 2010) that the availability of technology does not automatically ensure the changes in teacher`s pedagogical approach. Teachers demonstrated the efficient usage of ICT in only approximately a quarter of the observed lessons. ICT use is an effective tool if the teacher has chosen an appropriate teaching method according planned learning outcomes. It corresponds to (Ertmer & Ottenbreit-Leftwitch, 2010) that if teachers have the knowledge about meaningful use of ICT, and if they can manage the teaching/learning process according planned outcomes, the students' achievements will be better.

The challenge for the teachers is to be more open for the new learning strategies and to give students more clear and focused tasks to leave open the way with varieties of solutions with the usage of different ICT tools to reach planned outcomes. It gives us the information for the development of the next CPD programs that focus to ICT usage. It is not sufficient to move forward with reforms planned. There is a clear need to combine the ICT usage with focused pedagogical tasks for Science subject teachers. It corresponds to Fulan, that innovative teaching is pedagogy prior technology (Fulan, 2012).

It is well known that ICT equipment and software are constantly evolving and there is not enough information regarding the impact of their meaningful usage on students' academic achievements. That is why it is necessary to follow the developments' trend, continue the research activity, and provide new examples of ICT usage.

References

Campbell, C., Martin, D. (2010). Interactive whiteboards and the first year experience: Integrating IWB into pre-service teacher education. *Australian Journal of Teacher Education*, *35* (6), 68 – 75.

Dudareva. I., Brangule, A., Nikolajenko, A., Logins, J., Namsone, D. (2011). The development and implementation of meaningful ICT usage in sciences teaching and learning process in Latvia. In: *Science and Technology Education: Trends and Main Tendencies in the 21st Century* (Proceedings of International 8th IOSTE Symposium for central and Eastern Europe). Riga, 72-82.

Duran, M., Brunvand, S., & Fossum, P. (2009). Preparing science teachers to teach with technology: Exploring K-16 networked learning community approach. *The Turkish Online Journal of Educational Technology*, *8* (4), 21-42.

Ertmer, P. A., & Ottenbreit-Leftwich, A. T. (2010). Teacher technology change: How knowledge, confidence, beliefs, and culture intersect. *Journal of Research on Technology in Education*, *42* (3), 255-284.

France, I. (2010). The Research Skills in Mathematics Content for Grades 7 to 12, their Implementation into Practice. *Society, Integration, Education.* 207 – 214. Rezekne: Rezekne Higher Education Institution.

Fulan M. (2012). The moral imperative realized. Partners in learning. *Schools leadership Forum.* UK. Microsoft.

Mayer, R., E., Chanler, P. (2001). What learning is just a click away: Does simple user interaction foster deeper understanding of multimedia messages? *Journal of Education Psychology, 93*, 390 – 397.

FIRST STEPS IN ASSESSMENT OF STUDENTS' INQUIRY: A CASE STUDY OF NON-EXPERIENCED CHEMISTRY TEACHER

Karol Dudek, Paweł Bernard, Ewa Odrowąż
Jagiellonian University in Krakow, Krakow, Poland

Abstract

Teaching methods based on inquiry are more and more widely used in teaching natural sciences. In accordance with the new curriculum, introduced to Polish schools in 2008, students should gain new knowledge based on an inquiry. This fact is related to a change of teachers' approach in the didactic process and a change in the assessment system. This article undertakes an attempt to analyse how a teacher - who has theoretical knowledge in the field of IBSE teaching methods and evaluating students working in this manner - does the said in practice at the level of lower secondary school, during chemistry classes. The presented case study is based on didactic materials developed at the SAILS project.

Key words: *formative assessment, IBSE, case study, polymers*.

In 2008 in Poland a new curriculum for lower and upper secondary schools was approved. In accordance with it '*(...) The student gains chemical knowledge in the research manner – he or she observes, tests, verifies, draws conclusions and generalisations (...)*' (Polish Core Curriculum, 2008). The IBSE methods have been marked as one offering the potential to increase student's interest in natural science subjects at various educational levels. So far, there are few teachers who had an opportunity to get acquainted in practice with this method of work during lessons, and few of them has any knowledge about how to use inquiry in the course of their lessons (Bernard et al., 2012). Moreover, a teacher working with the inquiry methods encounters difficulties with assessing his students.

In the EU 7th framework programme, a number of projects were implemented to develop the methodology and didactic tools for IBSE (Establish); (The Fibonacci Project); (Primas); (Profiles); (Inquiry) as well as projects aimed at developing the IBSE assessment tools (SAILS); (Assist-me). In the majority of projects there have been foreseen trainings for teachers on the application of this method.

The object of the research was the implementation of teaching based on inquiry, together with an assessment of selected IBSE skills at the lower secondary school level during chemistry classes. The implantation was made by a very experienced teacher (>20 years in the profession), with good knowledge of IBSE methodology and assessment, but without practical experience.

The unit 'Properties of plastics' proposes the teacher a strategy of educational path and specifies what IBSE skills could be subject to assessment in the course of the lesson. This material developed in the ESTABLISH project and enriched with the assessment tools in SAILS project. The materials also offer a proposal on evidence collection methods and the types of tools that could be applied during the assessment. However, there were no concrete tools, examples or evaluation standards. The teacher was given the choice as to which class she is to teach the lesson in, he was to prepare the education path scheme, choose skills subject to assessment, the tools to collect data for students' assessment and to prepare criteria. The teacher was informed that the assessment form should be formative. The implementation results were discussed by the teacher in the form of a short report, subsequently the teacher was interviewed.

Before the class, the students did not know the topic of investigation. The teacher chose for the implementation the 3rd grade (15-16 years old) of lower secondary school students. Students had some basic knowledge about polymers. The class was composed of 11 students. The classes lasted 90 minutes, i.e. time equal to 2 lessons in the Polish educational system. The said classes were completed within one day. Students worked with the inquiry method for the first time.

The class began with a presentation to the students of the objective of the investigation and its general structure. At first the students discussed the topic of polymers – the questions suggested in the 'unit' were used in the discussion. Before proceeding to discuss the given issues, the students were supposed to write down their answers on sheets of paper. The signed sheets were collected at the end of the discussion (as a basis for the students' evaluation). The teacher was moderating the discussion, but she did not interfere with what the students were saying. After the end of the discussion, the students were divided into 5 groups. In the groups, they were supposed to perform laboratory experiments and complete their worksheets. Each group had access and was free to choose the common laboratory reagents and equipment for the given experiment.

Exercises topics:

1. Determining the density of plastics by comparing it to the density of water
2. Flammability of plastics (without the Beilstein test)
3. Thermal stability of plastics
4. Examining the thermal conductivity of plastics
5. Electrical conductivity of plastics.

The teacher has chosen three skills for assessment: discussion with peers, planning the experiment, and data collection. The assessment had formative character and was based on self-assessment sheet and rubrics.

After the classes the teacher concluded that the investigation was attractive and interesting for students. The prepared self-assessment sheet was useful to assess the discussion with peers, but not to assess planning of the investigation; and data collection. It was supposed to provide the possibility to evaluate separately students working in groups, but it did not work in practice. The teacher gave also a number of remarks about constructing and using rubrics. Her experience can be very useful for the teachers who start their work with IBSE and its' assessment.

At the presentation the details of designed assessment tools along with its evaluation will be discussed.

Acknowledgements

The study was conducted within the SAILS project. The project has received funding from the European Union's Seventh Framework Programme for research, technological development and demonstration under grant agreement no. 289085.

References

Assist - me Project. [online] Available at: < http://assistme.ku.dk/> [Accessed 30 January 2015].

Bernard, P., Dudek , K., Maciejowska, I., Odrowąż, E., Geoghegan, R. (2012). Introduction of inquiry based science education into polish science curriculum - general findings of teachers' attitude. *Chemistry Didactics Ecology Metrology, 17* (1-2), 49–59.

Establish Project. [online] Available at: < http://www.establish-fp7.eu/> [Accessed 30 January 2015].

Polish Core Curriculum. (2008). Act of the Polish Parliament. Regulation of the Minister of Education. Dz.U. 2008 Nr 4, poz. 17. Podstawa programowa z komentarzami, tom 5. Edukacja przyrodnicza w szkole podstawowej, gimnazjum i liceum.

PRIMAS. Project. [online] Available at: <http://www.promas.gr/en/servicessupport_en.htm> [Accessed 30 January 2015].

PROFILES. Project. [online] Available at: < http://www.profiles-project.eu/> [Accessed 30 January 2015].

SAILS. Project. [online] Available at: < http://www.sails-project.eu/portal > [Accessed 30 January 2015].

The Fibonacci Project. [online] Available at: < http://fibonacci-project.eu/> [Accessed 30 January 2015].

TRANSDISCIPLINARITY IN EDUCATION IS NEAR

Andrej Flogie
Institute Anton Martin Slomšek, Maribor, Slovenia
E-mail: andrej.flogie@slomskov-zavod.si

Kosta Dolenc, Boris Aberšek
University of Maribor, Maribor, Slovenia
E-mail: kosta.dolenc@um.si, boris.abersek@um.si

Abstract

In ancient Greece, knowledge was not neatly contained in distinct disciplines and leading scholars moved freely among different fields. The influence of reductionism, which began with Aristoteles and has continued ever since, created disciplines with precise boundaries. With such disciplinary approach, each field evolves independently as a specialized set of tools of analysis. The question arises: are these boundaries still necessary nowadays or must we look on the teaching/learning process more transdisciplinary? In this contribution, one of the possible ways will be shown and evaluated, how to model and apply an appropriate solution.

Key words: *transdisciplinary models, multidisciplinary models, cognitive education, neuroscience, holistic approach*.

Introduction

As disciplines reach maturity, a dynamic meta-structure is needed, which facilitates merging and new divisions of disciplines. Under such a meta-structure, the disciplines propel the evolution of knowledge, but adapt themselves when driving forces emerge sufficiently to provoke their adaptation (Suarez-Orozco, Satin-Bajaj, 2010). In the case of neuroscience and education, the more comprehensive understanding of learning is a compelling driving force as it is critical to broader goals such as sustainable economic growth, societal cohesion, and personal development (Hirsch Hadorn, et. al, 2008)

The current state of neuroscience, cognitive science and education provides a good illustration of the shortcomings of disciplinary separation (Aberšek, 2013). On learning, recent advances in neuroscience and cognitive science have produced powerful insights while educational research has accumulated a substantial knowledge base (Aberšek, Borstner, Bregant, 2014). A neuroscientific perspective on learning adds a new, important dimension to the study of learning in education, and educational knowledge could help direct neuroscience research towards more relevant areas. Because both fields are well-developed, however, they have deep-rooted disciplinary cultures with field-specific methods and language which make it extremely difficult for experts to use the knowledge from one field to the other (Nicolescu, Stavinschi, 2007). Fusing neuroscience, education and other relevant disciplines, and creating a new trans-disciplinary field would connect work on learning across the intellectual walls dividing disciplines (Figure 1).

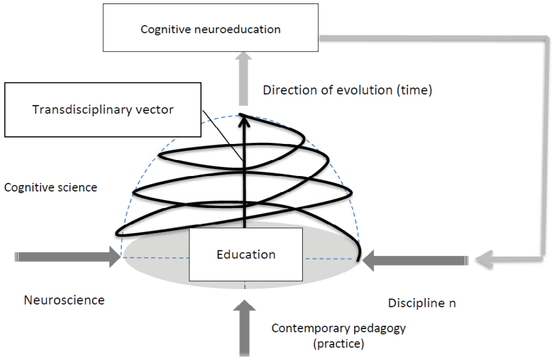


Figure 1: Birth of the new discipline: Cognitive neuroeducation.

Cognitive neuroeducation is generating valuable new knowledge to inform educational policy and practice: On many questions, neuroscience builds on the conclusions of existing knowledge and everyday observation, but its important contribution is in enabling the move from correlation to causation – understanding the mechanisms behind familiar patterns – to help identify effective solutions (Hirsch Hadorn, et. al, 2008) In this research the transformation of transdisciplinar *cognitive neuroeducation* model into practice will be observed and evaluated in the classroom.

Methodology of Research

The aim of the empirical research is the implementation and evaluation of the presented transdisciplinary approach (Hirsch Hadorn, et. al, 2008). Firstly, a transdisciplinary model for technology and science was designed and developed. Individualised content, which comprises various topics suitable for different levels of knowledge. The main research questions were mostly connected with problems in the field of educational results and connection of traditionally educational science with the contemporary one in the form as: Can transdisciplinary cognitive neuroeducation exchange traditionally teaching/learning methods?

Each school selected in the research participated with two classes arranged as follows:

One class represented *the control group*, where conventional lessons were carried out.

The second class represented *the experimental group,* in which teachers used a transdisciplinary model.

The performance data for the control group and the experimental group was acquired via summative assessment. In the control group, after the lessons were finished, a written summative assessment took place. The assessment was identical to that for the experimental group, with one exception; it was not in electronic form. At the end of the individualised learning process, a summative assessment in electronic form was carried out.

Results of Research

The results of the evaluation clearly show that, with the use of transdisciplinary cognitive neuroeducational model of teaching/learning, the achieved results are more than 10-15% better when compared to traditional lessons, which was expected. But what is more important, at the start of using the proposed model, it was calculated that approx. 30% of students fall within the lower cognitive level and 70% within the higher. However, the measurements at the end of training showed that only 15% of students were within the lower cognitive level, which clearly indicates the advance in student knowledge levels that was achieved with the help of the proposed model. The research is in the pilot phase, so the better results can be expected in future.

Conclusion and Implications

The presented transdisciplinary model is the biggest challenge for both schools and modern teaching/learning environment. It turned out that, despite individualised learning and adjusted content, the motivational element or the capacity for learning by oneself plays the key role in working and learning with the help of the proposed model. Following the student's every step, yields better insight into the student's motivation and his or her ability to self-learning. This will be a challenge for future research.

References

Aberšek, B. (2013). Cogito ergo sum homomachine? *Journal of Baltic Science Education, 12* (3), 268-270.

Aberšek, B., Borstner, B., & Bregant, J. (2014). The virtual science teacher as a hybrid system: Cognitive science hand in hand with cybernetic pedagogy. *Journal of Baltic Science Education, 13* (1), 75-90.

Hirsch Hadorn, G., Hoffmann-Riem, H., Biber-Klemm, S., Grosenbacher-Mansuy, W., Joya, D., Pohl, C., Wiessmann, U., Zemp E. (2008). *Handbook of transdisciplinary research*. Springer Science + Business Media B.V.

Nicolescu, B., Stavinschi, M. (2007). *Transdisciplinarity in science and religion*. Bucuresti, Romania: CurteaVeche Publishing House.

Suarez-Orozco, M. M., Satin-Bajaj, C. (2010). *Educating the whole child for the whole world. The Ross school model and education for the global era.* New York and London: New York University Press.

SOME ASPECTS OF THE CONSTRUCTION OF THE THEMATIC TESTS FOR THE DIAGNOSIS OF COGNITIVE LEARNING OUTCOMES CHEMISTRY ENGINEERING STUDENTS

Liudmila Gorbunova
Admiral Makarov State University of Maritime and Inland Shipping,
Archangelsk region, Russia
E-mail: gorbunov_a@mail.ru

Abstract

The article discusses the procedure of the preparation of test materials for the diagnosis of cognitive learning outcomes in chemistry. It is shown that the use of the thesaurus approach to the selection of the content and methods of mathematical statistics provides a test with high reliability and validity coefficients.

Key words: *diagnostic test, chemistry, educational measurement.*

Introduction

Evaluation of the results of students' learning activities is one of the most important components of the educational process, as it allows establishing a relation between forecasted and actual learning outcomes achieved. For this purpose in Russia in recent years pedagogical tests are widely used in the practice of teachers and university professors (Nokhrina, 2002; Tchernyaev and Akhmetov, 2001). In Russia, a centralized database of test materials developed by the Federal Institute of Education Measurement (FIPI). These materials are used only for the purposes of the final certification of pupils and students. Usually many teachers independently develop such material for thematic testing and they take it in educational measurement of latent characteristics of pupils. But not many teachers are asking themselves "Are the tests created by me, in fact, the "gauging tools"?

We introduce some definitions. Pedagogical measurement is called the process of establishing correspondence between the estimated characteristics of learners and empirical points of the scale, in which the relationship between the different estimates of the characteristics are expressed properties of numerical series. Measuring means is performed by a pedagogical test, by which we mean a system of pre-test tasks ordered within a certain strategy and presented in an informative assessment at a level of students' training. Pedagogical test only then becomes the measurement and control test material and can be used to determine of the latent properties of students' personality – at the level of training, if it has a high coefficient of reliability, content and predictive validity. Only in this case pedagogical test will give permission to obtain unbiased assessments of the students' training levels (Ananesov, 2008).

Methodology of Research

The study used the following methods: analysis of scientific literature, the content analysis of the Federal Standard of Higher Education in the direction of preparation 140400.62 profile “Electric drive and automation”, systemic, structural, statistical and factor analysis, interpretation, compilation and systematization of the results.

Results of Research

The development of thematic test materials for diagnosis of cognitive learning outcomes of chemistry engineering students, was carried out in several stages.

At the first stage, we selected such training content which will be diagnosed. To do this, we take into account the projected learning objectives defined in the Federal Standard of High Education, such as the next competence “the ability to demonstrate a basic knowledge of natural sciences and willingness to use the basic laws in professional activities ...”. Therefore, the selection of the invariant part of the content of the chemical knowledge and methods of their performance, we carried out within the thesaurus approach (Gorbunova, 2013) and in accordance with the list of didactic units of the chemistry contents.

At the second stage, we developed a strategy of the pretest task presentation and specifications of the test, by linking the forecasted knowledge and skills with the percent correlation of tasks into the test in accordance with Bloom’s taxonomy (Bloom, 1956).

In the third step we designed pretest tasks, preferring the type of closed tasks with a choice of the correct answer of the four proposed. These tasks are suitable for thematic and final knowledge control of factual material on the discipline (concepts, definitions, terms, laws, formulas) and abilities of the students to apply the laws and formulas to solve problems, to interpret the results on the charts and diagrams, to carry value judgments. They are characterized by simplicity and objectivity in assessing the results of education, but rather complex in design, especially in the selection of distractors that must be believable. “A reasonable set of distractors is an integral part of the procedure for the preparation of reliable and valid test» (Neiman, Khlebnikov, 2000). Selection of pretest tasks under the formation of thematic tests was performed according to the chosen strategy presentation and a priority of the author’s estimates of the task difficulties. So, we constructed eight thematic tests, which contained only pretest tasks of closed type. Every thematic test consists of 10 to 25 pretest tasks covering the 8 topics of the subject content of “chemistry”. For example: “Atomic structure and properties of the free atoms”, “Periodic law of chemical elements”, “Chemical bonding”, “The main classes of inorganic compounds”, “Energy and the rate of chemical reactions”, “Solutions of weak electrolytes”, “Hydrolysis of salts” and “Polymers”.

In the fourth stage, we obtained empirical data in the procedure of students’ testing, which was attended by the students of the first year of full-time and part-time forms of education. In the fifth stage, we performed the quality assessment of tests, which included an assessment of the plausibility of distractors. For this purpose, we used parametric criterion $\chi 2$ at a significance level of 0.05, and a method calculation of point-biserial correlation coefficient. That method allowed us to define as non-worked distractors, and the random nature of their use. The discriminative of the test questions we determined by counting the point-biserial correlation coefficients. We determined the degree of the homogeneity of our pedagogical control and the measurement materials by the method of pairing correlations. The reliability of our thematic tests was evaluated by calculating the coefficient of reliability by retest method and by method of Kuder-Richardson (Linn, 1989), because we used a dichotomous scale. The calculated values of the reliability coefficient of test composition are in the range 0.75-0.87. We have found that the value of the reliability coefficient depends on the length of the test. It was found that the longer the length of the test, the more likely that this test has a higher value of the reliability coefficient, which is consistent with tendency noted in the literature (Chelyshkova, 2002). The value of the reliability coefficient we used to calculate the boundaries of the confidence interval in which should be the true assessment of the students' cognitive learning outcomes knowledge. We have adopted that an acceptable level of risk is equal 5%. The content validity of every thematic test was assessed by the completeness of reflection in the test of invariant object content in accordance with the requirements of FIPI. We determined the predictive validity by the correlation of test results obtained from different thematic tests of the individual student. In cases of high correlations we expected an advanced level of formation of the students' projected learning outcomes. Interpretation of the test results, we carried out within the framework of the traditional theory, determining the students' test-level on the competency scale.

Conclusions and Implications

The above aspects of the construction of pedagogical tests are invariant. Their step by step use allows you to create the measurement and control materials with high reliability. Without logically impeccable form and pedagogically sound content of test questions, there couldn't be obtained objective assessments of learning outcomes of students.

Acknowledgment

The author thanks the staff of the department for help in processing the results of the study.

References

Avanesov, V. S. (2008). The problem of objectivity educational measurement. *Pedagogical Dimension*, *3*, 3-40.

Bloom, S. A. et al. (1956). Taxonomy of educational objectives: The classification of educational goal. Handbook 1: Cognitive domain. N.Y.: David Mckay Co.

Chelyshkova, M. B. (2002). Theory and practice of designing pedagogical tests. Moscow: Logos.

Gorbunova, L. G. (2013). Tezaurus approach to the selection of content and diagnostic tools in chemistry at the Technical University [Actual problems of ecological and chemical education]. St. Petersburg: RSPU named by A. I. Herzen Press.

Linn, K. L.(1989). *Educational measurement* (3 rd ed.). N.Y.: Macmillan.

Nokhrina, N. (2002). Test control system. *Higher education in Russia*, *1*, 106-107.

Tchernyaev, N. N., & Akhmetov, M. A. (2001). Test items and individualized instruction. *Chemistry at School*, *9*, 46-49.

EXAMINING EFFECT OF ANIMATION APPLICATIONS ON STUDENT ACHIEVEMENT IN SCIENCE AND TECHNOLOGY COURSE

Sedat Yüksel
Uludag University, Bursa, Turkey
E-mail: sedaty@uludag.edu.tr

Mestan Boyaci
S. K. B. Ufuk Bülent Yavuz Secondary School, Bursa, Turkey

Abstract

The aim of this study was to determine whether or not animation applications affect student achievement in science and technology course. For this purpose, effect of constructive approach supported by animations in the instruction of the unit "Living Organisms and Energy" to the 8th grade students on their academic achievement was investigated. This unit was taught to the experimental group using a constructivist approach supported by animations and to the control group using a constructivist approach without animations. For data collection, an achievement was developed and administered to experimental and control groups as pre-tests and post-tests. Collected data was analyzed using t-test and MANOVA. As a result of the research, it was revealed that supporting the constructivist approach with animations was more effective in increasing academic achievement.

Key words: *animation, constructivist science education, teaching supported by computer.*

Introduction

In Turkey in 2004, the National Education Ministry gave up behaviorist approach and developed primary education curriculums – including science and technology education curriculum – in accordance with constructivist approach. In these curriculums, the major purpose of science and technology course was not to make students memorize science concepts, but to provide them improve their thinking skills by teaching them how to learn and to school them as inquisitive and inquiring individuals. In constructivist approach, the teacher performs roles of organizing and facilitating different from traditional instruction. By organizing an appropriate learning environment, the teacher tries to make the student an active member of this environment. As for student always wonder in the learning process and research as wondering. (Brooks & Brooks, 1993; Demirel, 2015)

One of the techniques used in the instruction of science and technology course is computer assisted animation technique. In terms of abstract concepts, visual concretization paves the way for interactive learning, animations provide important educational learning opportunities. In this way, it can be possible to create a rich learning environment for the student (Bülbül, 2009).

Animations used in science instruction help students to code presented content visually. If the learner codes the content both verbally and visually and constructs these in mind again, then he/she can learn meaningfully. The positive effect of advances in computer technology in the animation area enabled animation applications in computer. Especially, in the computer environment integrated multimedia technologies, graphics and texts of real images, opportunities of combining real voice and animations provide many advantages in the educational software realization process.

Researches done present numerous benefits of teaching supported by animations (e.g. Daşdemir, 2006: Daşdemir, 2012; İnaç, 2010; Kolomuç, 2009; Rotbain, Marbach-Ad & Stavy 2008; Sezgin, 2002). For this reason, in schools of several countries, animation usage in different courses became widespread. However, although animations provide many advantages, inadequate usage of animations in primary science and technology courses in Turkey drew attention. Therefore, it was intended to make up this insufficiency with this study. That’s why, the aim of this research was to confirm the effect of animation applications in science technology courses on students’ academic achievement.

Methodology of Research

This study was designed as an experimental research. In the research, there was an experimental group taught using a constructivist approach supported by animations and a control group who were taught using only a constructivist approach. The research was conducted on 50 eighth grade students studying in two different classes of two secondary schools in Bursa, Turkey. Each of the classes has the same number of students, namely 25 students and one of them was assigned to the experimental group and the other - to the control group.

As an instrument, Science and Technology Achievement Test (STAT) formed of 36 questions involving “Living Organisms and Energy” unit was developed and used. The prepared instrument was administered as pre-test and post-test. The implementation of the courses had continued for 4 weeks in both groups.

Results of Research

In the research, firstly, STAT was administered as a pretest on experimental and control groups.Among the pre-test scores of two groups no significant differences were found. In other words, before the experimental implementation, academic achievement levels of the groups were indifferent. According to the analysis done after the experimental treatment, academic achievement levels of experimental and control groups differentiated in favor of the experimental group. As to this result, animation application in science and technology course affects student achievement in a positive way. Also, with the analysis, it was determined that gender had no effect on students’ science and technology course achievement, but only the animations implemented on the experimental group had that effect on student achievement.

Conclusion and Implications

In science and technology education, computer assisted animation method has an important effect on student achievement. In consequence of the research, it was shown that post-test scores of the students in experimental group being higher than the students in the control group had been provided by the animations. With the multidirectional usage of educational technology and animations in science courses, students' existing interest and wonder will increase more. In the end, their academic achievement in this course will be higher. For this reason, it required that more place should be given to computer assisted animations in science education. On the top of it, in the schools not having laboratory opportunities and suffering from material insufficiency, thanks to animations students' learning the topics effectively will be provided.

References

Brooks, J. G., & Brooks, M. (1993). In search of understanding: The case for constructivist classrooms. Alexandria, VA: ASCD.

Bülbül, O. (2009). F*izik dersi optik ünitesinin bilgisayar destekli öğretimde kullanılan animasyonların ve simülasyonların akademik başarıya ve akılda kalıcılığa etkisinin incelenmesi* [*Simulations and animations effects in computer assisted instruction on academic success and retention when teaching of optic unit in physics]* (Unpublished master's thesis). Çukurova University, Turkey.

Daşdemir, İ. (2006). *Fen bilgisi dersinde animasyon kullanımının akademik başarı ve kalıcılığa etkisi* [*The effect of using animations on students' academic achievements and retentions in primary science course]* (Unpublished master's thesis). Ataturk University, Turkey.

Daşdemir, İ. (2012). *İlköğretim fen ve teknoloji dersinde animasyon kullanımının öğrencilerin akademik başarılarına, öğrenilen bilginin kalıcılığına ve bilimsel süreç becerilerine etkisi [The effect of using of animation on students' academic achievement, retention of learned knowledge and scientific process skills]* (Unpublished Phd thesis). Ataturk University, Turkey.

Demirel, Özcan (2015). *Öğretme sanatı* [The art of teaching]. 21. Edition. Ankara: Pegem.

İnaç, A. E. (2010). *Animasyon kullanımının ilköğretim öğrencilerinin fen ve teknoloji dersindeki akademik başarılarına ve akılda tutma düzeylerine etkisi [The effect of using animations on the primary school students' academic achievement and retention levels in science and technology lesson: 6th, 7th and 8th grades sample]* (Unpublished master's thesis). On sekiz Mart University, Turkey.

Kolomuç, A. (2009). *11. sınıf "Kimyasal Reaksiyonların Hızları" ünitesin 5E modeline göre animasyon destekli öğretimi* [*Animation based instruction on rate of chemical reactions unit in grade 11 in regard to 5E model]* (Unpublished phd thesis). Ataturk University, Turkey.

Rotbain, Y., Marbach-Ad, G., & Stavy, R. (2008). Using a computer animation to teach high school molecular biology. *Journal of Science Education and Technology*, *17*, 49–58.

Sezgin, M. (2002). *İkili kodlama kuramına dayalı olarak hazırlanan multimedia ders yazılımının fen bilgisi öğretimindeki akademik başarıya, öğrenme düzeyleri ve kalıcılığa etkisi [The effects of multimedia courseware designed based on dual coding theory in science teaching on academic achievement, performance level and retention of learning]* (Unpublished master's thesis). Çukurova University, Turkey.

AN APPROACH TO TEACHING MEDICAL CHEMISTRY THAT HIGHLIGHTS INTERDISCIPLINARY NATURE OF SCIENCE

Aris Kaksis, Agnese Brangule, Mihails Halitovs
Riga Stradiņš University, Riga, Latvia
E-mail: ariska@lanet.lv

Abstract

Thermodynamics is a branch of physics that deals with questions concerning energies and work of a system. It is one of the key topics for understanding processes in the universe as well as any separate system like a gas mixture or a single cell in a biological system. Thermodynamics is included in the university curriculum for engineering, chemistry and physics students as well as medical student curriculum.

This paper outlines the problems faced by first year medical students learning thermodynamics at Riga Stradinš University. We describe a medically relevant context based approach to teaching that demonstrates the interdisciplinary nature of medical chemistry, molecular biology and biochemistry. Our method provides a model in which disciplinary barriers are diminished and increased effectiveness of teaching is achieved.

Key words: *interdisciplinary teaching, medical chemistry, thermodynamics, teaching and learning thermodynamics.*

Introduction

One of the main and biggest programs in Riga Stradins University is “Medicine”. Medicine studies start with theoretical disciplines, which comprise subjects from different fields of science as well as the social classes. Medical students are eagerly waiting for preclinical and clinical subjects. Therefore, starting the studies with chemistry and thermodynamics is slightly disappointing and distressing for a part of students. It is very common to hear students saying “That is not a part of chemistry!” and asking “Why medical students need thermodynamics?”. A quote of famous German scientist says: “Thermodynamics is a funny subject. The first time you go through it, you don’t understand it at all. The second time you go through it, you think you understand it, except for one or two small points. The third time you go through it, you know you don’t understand it, but by that time you are so used to it, so it doesn’t bother you anymore” (Thermodynamics, 2015).

A literature research was conducted to investigate the factors as predictors of student success in physical chemistry (Derrick, Derrick, 2002; Hahn, Polik, 2004; Nicoll, Francisco, 2001; Bain, Moon, Macka, Towns, 2014). It was concluded that students face difficulties in retention of knowledge when the traditional teaching method is used. We outlined the purpose of this work: to provide a model in which disciplinary barriers in medical chemistry, molecular biology and biochemistry are diminished and teaching can be easily adapted to student with diverse levels of previous knowledge in chemistry.

Methodology of Research

A literature research was done to study factors influencing success in learning and teaching physical chemistry. A scheme was created for medical chemistry, biochemistry and molecular biology subject interaction and covered topics (Sumter, Owens, 2011). The thermodynamic content in each topic was split into levels - knowledge, usage, context and calculations. The scheme was then introduced to students proving to be easily understandable and motivating to learn the topics.

A study was conducted involving surveys (Sokrata, Tamania, Moutaabbida, Radid, 2014) of 30 students of the first semester and 60 second semester students. The first semester students were offered a new interdisciplinary model and were able to follow the scheme, showing the cross-curricular links. The second semester students were divided into two groups – 30 students who had studied medical chemistry using the old model, and the other 30 that have studied using the new curricular model.

Results of Research

The surveys of the second semester students who followed the new teaching model indicates that they were able to successfully link and use previously taught knowledge of chemistry to biochemistry contents. The first semester students indicate interface in the content in medical chemistry and molecular biology. Almost all of the students, who studied according to the new model, emphasise that this model has changed their learning habits - they are trying to understand the processes and use the knowledge gained to solve related problems, not just memorizing facts by heart.

Conclusions and Implications

The developed model allows to look at the teaching and learning process of chemistry (specifically, thermodynamics) in a broader context of both the students' and teachers' side. Interface and cover topics contribute to students' motivation to learn. Levels in thermodynamics content allow acquiring the complex content for students, whose previous knowledge of chemistry is in medium level. Biochemistry, biology and thermodynamics context makes content meaningful and interesting.

References

Bain, K., Moon, A., Macka, M., Towns, M. (2014). A review of research on the teaching and learning of thermodynamics at the university level. *Chemistry Education Research and Practice*, *15*, 320-335. DOI: 10.1039/C4RP00011K.

Derrick, M. E., Derrick, F. W. (2002). Predictors success in physical chemistry. *Journal of Chemical Education, 79* (8), 1013-1016. DOI: 10.1021/ed079p1013.

Hahn, K. E., Polik, W. F. (2004). Factors influencing success in physical chemistry. *Journal of Chemical Education, 81* (4), 567-572. DOI: 10.1021/ed081p567.

Nicoll, G., Francisco, J. S. (2001). An investigation of the factors influencing student performance in physical chemistry. *Journal of Chemical Education, 78* (1), 99-102. DOI: 10.1021/ed078p99.

Sokrata, H., Tamania, S., Moutaabbida, M., Radid, M. (2014). Difficulties of students from the faculty of science with regard to understanding the concepts of chemical thermodynamics. *Procedia - Social and Behavioral Sciences*, 368–372, DOI:10.1016/j.sbspro.2014.01.223.

Sumter, T. F., Owens, P. M. (2011). An approach to teaching general chemistry II that highlights the interdisciplinary nature of science. *Biochemistry and Molecular Biology Education, 39* (2), 110-6. DOI: 10.1002/bmb.20465.

Thermodynamics (2015). Retrieved April 2015, from http://www.eoht.info/page/Arnold+Sommerfeld

USAGE OF CRITICAL THINKING PRINCIPLES IN MEDICAL CHEMISTRY COURSE

Irina Kazuša
Rīga Stradiņš University Latvia, Riga, Latvia
E-mail: Irina.Kazusa@rsu.lv

Abstract

This research describes the development of didactic model based on critical thinking principles and its practical approbation in medical chemistry course. The effectiveness of the didactic model is evaluated as achieved level in medical chemistry course (theoretic knowledge, experimentation skills and problem solving skills) using critical thinking development methods. In addition to this, self-assessment skills and development of studying skills are also analyzed.

Key words: *critical thinking strategies, critical thinking principles.*

Introduction

Higher education teaching that focuses only on the first issue, that is, knowledge and understanding, misses the opportunity to help students engage with their learning on a deeper level. Thus, teachers should be able to plan for and deliver coherent learning which accelerates progress, deepens understanding and knowledge, and develops a range of skills and 'learning behaviours', such as problem solving, interaction with teachers and other learners, self-correction, critical reflection, competence improvement, meaning making, and experiential learning (Report to the European Commission, 2013).

Medical chemistry course introduces students to regularities of chemical transformations providing homeostasis. At the same time the didactic model based on critical thinking principles used in medical chemistry course serves as a general guide helping students to choose study methods and study organization forms best suited for one's own goals thus broadening usage of already known methods.

Methodology of Research

The didactic goal is to "create logical tools" to be used for solving two of the most important problems which practitioners face - precise diagnostics and choice of suitable treatment. At the beginning of the study process, though, it is problem recognition and choice of solutions while justifying and defending one's position. It is this goal which demanded using critical thinking principles to be used: argument analysis, conclusions, examination of hypothesis, evaluation and decision making. In system of R. Paul, critical thinking principles are the unifying element between the basic concept and specific strategies (Paul, Binker, Douglas, Adamson, 1989).

The concept was based on student-centered learning (Rogers, 1983), information succession (Brunner, 1966) and systemicity (Broks, 2000) in developing student independence as an element of self-imposed studies (Knowles, 1975). The didactic model was based on ideas of cognitivism (Piaget, 2002), critical constructionism (Brunner, 1996) and pragmatism (Dewey, 1919) as well as didactics of chemistry.

Study results were determined based on criteria developed for evaluating medical chemistry course result quality and corresponding critical thinking levels well illustrated by student grades in finals - exam and questionnaire.

Conclusions and Implications

The questionnaire showed that the goal of this research - methodical solution for mastering medical chemistry course using critical thinking development methods - is reached since students have either fully or partially learned:

- to develop skills for searching information in books as well as other sources;
- to formulate tasks in a concise manner corresponding to their own level of expertise;
- to anticipate which methods will be more effective based on existing experience;
- to control the factors impeding development of personal study plan;
- to independently develop personal study material by using recommended study materials and other sources;
- to critically evaluate and determine what information - in addition to recommended - is necessary and why some problems aren’t fully understood and whether there is a need for authoritative opinion;
- to summarize what was done correctly and what could have been done better as well as whether actions taken were consistent and lead to success;
- to transfer responsibility from lecturer to student - student has to be able to use lecturers to their full potential.

References

Broks, A. (2000). *Izglītības sistemoloģija [Systemology of education]*. RaKa, Rīga.

Bruner, J. (1966). *Toward a theory of instruction*. Cambridge, MA: Harvard University.

Knowles, M. S. (1975). *Self-directed learning: A guide for learners and teachers*. Englewood Cliffs: Prentice Hall/Cambridge.

Paul, R., Binker, A., Douglas, M., Adamson, H. (1989). *Critical thinking handbook: High school a guide for redesigning instruction*. Center for Critical Thinking and Moral Critique Sonoma State University Rohnert Park.

Piaget, J. (2002). Bērna intelektuālā attīstība /Žans Piažē; The child’s intellectual development (translated by Sarmīte Meinerte). Rīga: Pētergailis. Original work published 1936.

Report to the European Commission on improving the quality of teaching and learning in Europe’s higher education institutions June 2013. 35. pp. (2014, September 26). Retrieved from: http://ec.europa.eu/education/library/reports/modernisation_en.pdf

Rogers, C. (1983). Freedom to learn for the 8O’s. Columbus-Toronto-London-Sydney: Charles E. Merrill Company, A Bell & Howell Company.

Дьюи, Д. (1919). *Психология и педагогика мышления* /Д. Дьюи; пер. translated by N. Nikolskaja). Москва: Издание Т-ва «Мир». Original work published 1909.

CONTENT LINES IN DESIGN OF CHEMICAL EDUCATION FOR WOULD-BE ENGINEERS

Vitali Khaletski
Brest State Technical University, Brest, Belarus
E-mail: chalecki@inbox.ru

Abstract

Methodology of chemical education for would-be engineers in technical universities is discussed in the report. Content lines as an instrument of structuring of content of chemical courses are proposed by the author. Content lines and their practical implementation in syllabus are analyzed. It was shown that the method of syllabus design makes education area more transparent for all participants of educational process.

Key words: *content lines, engineering education, curriculum design.*

Introduction

Chemistry is an obligatory unit in curriculum for students of almost all technical specialities in the Republic of Belarus. Usually duration of the unit is one or less often two semesters in the first year. Depending on speciality it includes 32 or 50 hrs of lectures and 16 or 32 hrs of laboratory classes. Traditionally the content of chemical education for would-be engineers is based on the general chemistry course and it is not strongly connected with future professional activity of the students and their every-day life. This is one of the reasons for the low motivation of students to study chemistry. Most of them simply do not see the practical applicability of chemical knowledge. Another reason is that the admission procedure to the technical universities includes entrance exams (centralized testing) in Belarusian or Russian language, Physics and Mathematics. Matriculants do not pass entrance exams in Chemistry and as a result they pay less attention to graduate classes at school. At the same time it is obvious that the quality of chemical education will determine the overall level of skills of the future engineer.

The number of students of engineering specialities in the Republic of Belarus is very large. In 2014 according to official data 11,539 students were enrolled at universities to specialities in section “Technics and Technologies” and 3,066 students were enrolled to specialities in section “Architecture and Civil Engineering” respectively. This was 24,7 % of the total matriculants in Belarus (Higher education…, 2015, p. 19). For this reason, the problem of design of chemical education for would-be engineers is of current interest.

Methodology of research

The content of the chemical education for would-be engineers in Belarus has been studied since the 1930’s to the present. Foreign practices in organization of chemical education in technical universities have been analyzed. At the same time detailed questioning of students of technical specialities to determine their attitude to the Chemistry was held in 2010 (1,048 respondents) and in 2013 (85 respondents).

Results of Research

The study found that the most common model of the course in chemistry for would-be engineers is a traditional course in general chemistry. The main topics were determined in its main features in 1960's. The short description of the course includes stoichiometry, atomic structure and bonding, thermodynamic, kinetics, equilibrium, solutions, ionic reactions, electrochemistry, corrosion of metals and protection methods, electrolysis, polymeric materials. However, the survey results showed that the content of the course is necessary to significantly revise.

Firstly, only about 30 % of the respondents believe that chemistry will be needed in their future activity. That is why special attention should be paid to the connection between the content of chemical education and peculiarities of professional tasks of the engineering careers.

Secondly, a little more than 50 % of respondents are confident that knowledge in chemistry is helpful in every-day life. Hence chemistry course should finally convince all that chemistry is a useful and applied science.

Thirdly, up to 70 % of respondents believe that chemistry is the most responsible science for world's environmental problems. Only about 10% of respondents blamed physics for these. It means that we have to show not only the role of chemistry in the pollution of the environment. But above all we need to demonstrate the importance of chemistry for solving environmental problems.

So, there is a problem how to organize such a diverse educational material in relatively short duration of a chemistry course. In Brest State Technical University *content lines* were used by the author as an instrument of structuring of content of chemical education for would-be engineers. Content lines form the template of syllabus of chemistry course. There have been used the following lines:

– substance: composition, structure and properties,
– chemical process: energetics, rate and equilibrium,
– chemical methods of identification and quantification of substances.

These three lines form invariant part of syllabus for students of different specialties. They correspond to classical course of general chemistry. Also three additional lines were proposed:

– chemistry and engineering as an area of future professional activity,
– chemistry and environment protection,
– chemistry and every-day life.

These three content lines form variable part of syllabus. They help to adjust the content of chemical education to needs of future profession of students. Fight against prejudice with regard to chemical science is another important role of these lines. And of course they help students to realize significant role of chemistry in sustainable development and environment protection.

Some examples of practical implementation of content line *chemistry and environment protection* for students specialized in operation of cars and vehicles are given in table 1.

Table 1. Description of environment problems in syllabus in General Chemistry.

Topic	Content
Chemical Thermodynamics	Calorific value of the fuel, biofuel, ethanol: heat of combustion and fuel balance, rapeseed oil as a raw material for the production of diesel fuel, environmental and ethical issues of biofuel production
Chemical Kinetics	Oxygen sensors and catalytic converter
Solutions	Automotive antifreeze: the ethylene glycol poisoning
Electrochemistry	The disposal of waste batteries; lead-acid battery: construction of battery and environmental issues, the lithium-ion batteries: construction and environmental problems, fuel cells in solving of the energy problem
Chemistry of metals	Environment problems of modern metallurgy, heavy metal compounds as environment pollutants
Polymers	Specificity of waste plastics, degradable polymer materials, combustion and pyrolysis as methods of polymer waste management, recycling of polymers

Conclusions and Implications

Content lines make education area more transparent for the students. They provide that syllabus in general chemistry becomes more holistic and understandable both for students and for professors. The results of questioning of the students held after final exam show that up to 90 % of the respondents improve their attitude to chemistry as a science.

References

Higher education in Republic of Belarus: Information and regulatory provision of admission procedure. (2015). Minsk: Republic Institute of Higher School (in Russian).

ONLINE SCIENCE LITERACY: TO TEACH OR NOT TO TEACH

Metka Kordigel Aberšek
University Maribor, Slovenia
E-mail: Metka.Kordigel@um.si

Abstract

The paper presents the results of the study, which examined science teachers' evaluation of online science literacy competence in their students. Data was collected through adopted TICA questionnaire for accessing students' basic computer competence, finding a suitable website, locating information on the website and critically evaluating the information. Results show: the digital generation does not enter the school as online literate. Online (science) literacy is developing in the educational process – and must be taught in the educational process.

Key words: *inferential reasoning, metacognition, online science literacy, hypertext comprehension.*

Introduction

Online science literacy is defined as an essential part of science literacy – as a competence to find, evaluate and use science knowledge stored on internet (as a part of extended memory) to solve a problem in a science class and to construct students' own science knowledge, as a storage and as a source of knowledge for teaching/learning process in the science class, to revaluate their online teaching practice and the need for implementation of online science literacy in their science curriculum.

ICT supported natural science education is using a didactical paradigm, according to which students don't learn data any more. Memorizing knowledge is, according to this approach, not necessary, since knowledge is always available on the www "just a click away". To use such paradigm a teacher must be absolutely convinced, his students are online literate. Some researchers are convinced the digital generation enters the school qualified to use digital tools, ICT education is offering (Veen, Wraking, 2006), - many other are calling attention to the differences among the students (Wästlund et. al., 2005, Landow, 2006). Online literacy is a very complicated structured competence (Coiro, Dobler, 2007) – and is, in different students, emerging/developing differently. Research shows: expert e-readers are using by their successful reading of e-texts different kind of inferential reasoning processes and different metacognitive processes which contribute to better comprehension.

Table 1. Similarities and differences between linear and open hypertext readings.

Reading comprehension strategies	Similarities between linear and open hypertext reading	Additional complexities, needed in open hypertext comprehension processes

Prior knowledge	• prior knowledge of the topic
	  • knowledge
	  • misconceptions
	  • vocabulary (general, specific)
	• prior knowledge of printed informational text structures
		• prior knowledge of hypertext structure/website structure
		• prior knowledge of Web-based search engines - basic skills
		  • computer basics
		  • navigational basics
		  • Web searching basics

Inferential resoning	• creating coherence:
	  • text based coherence
	  • general representation (situation model)
	• Inferential reasoning strategies:
	  • literal matching skills
	  • structural cues
	  • context clues
		• forward inferentional reasoning
		• multilayered reading process across hypertext stucture and three dimensional Internet spaces

Metakognitive/self-regulated processes	• conventional fix-up strategies for comprehension monitoring and repair • conected components of a larger strategic reading process • selfregulated recursive circle	• self regulated recursive circle intertwined with physical reading actions (typing, clicking, scrolling, dragging) • rapid information-seeking cycles within extremely short text passages

Methodology of Research

Data was collected through a 26-items Likert – scale questionnaire. The items were adopted from the TICA questionnaire for accessing students' online reading competence (Leu et al. 2014). Online science literacy assessment was defined in terms of the following aspects: basic skills (which include computer basics, web searching basics, and general navigation basics), locating information, finding a suitable website, locating the information on the website, critically evaluating the information according to its reliability and according to its relevance for the science class assessment. Science/natural science teachers from 5 different levels of pre-university education (1st, 2nd, 3rd triennium of compulsory school, civil engineering vocational school and gymnasium) accessed their students' online science literacy.

Results of Research

The preliminary results show a noticeable difference in comparing online literacy in children of different age. Children of 1st triennium (age 6 – 8) are, according to teachers' assessments, quite clumsy at using Internet as a source of information and for saving this knowledge for the future use. Online literacy is growing with the age, but the differences between students in one generation remain.

Conclusions and Implications

The primary goal of explicatory text in e-textbook and on World Wide Web, used in science class, is to deliver information. Consequently, a student in science class must be able to find, extract and save the relevant information from the e-text. A teachers' precise conception of online literacy in his students will minimize the damage, which would origin from using e-learning material by students with the lack of pre-knowledge and pre-experience with computers and searching engines, which have difficulties in all (or some) kinds of inferential reasoning and which do not monitor and self-regulate their e-reading/e-learning process. Successful evaluating their students' e-literacy is teachers' perquisite (DeStefano, Le Fevre, 2007; Mangen et. al., 2013) in the process of deciding, which e-textbooks and www sites could be suitable for his students in the e-learning process.

References

Coiro, J., Dobler, E. (2007). Exploring the online reading comprehension strategies used by sixth-grade skilled readers to search for and locate information on the Internet. *Reading Research Quarterly*, *42* (2), 214-257.

DeStefano D., Le Fevre, J. A. (2007). Cognitive load in hypertext reading: A review. *Computers in Human Behaviour, 23,* 1616-1641.

Leu, D. J., Coiro, J., Castek, J., Hartman, D. K., Henry, L. A., Reinking, D. (2015). Research on instruction and assesment on new literacies of online reading comprehension. Retrieved from http://newliteracies.uconn.edu/wp-content/uploads/sites/448/2014/07/Leu_et_al_Final_Chaptersinglespaced.pdf

Landow, G. P. (2006). *Hypertext 3.0: Critical theory and new media in an era of globalisation*. Baltimore, Maryland: The Johns Hopkins University Press.

Mangen, A., Walgermo, B. R., Bronnick, K. (2013). Reading linear texts on paper versus computer schreen. *International Journal of Educational Research, 58*, 61-68.

Veen, W., B. Vraking (2006). *Homo Zappiens. Growing up in a digital age*. London: Network Continuum Education.

Wästlund, E., Reinikka, H., Norlander, T., Archer, T. (2005). Effects of VDT and paper presentation on consumption and production of information: Psychological and physiological factors. *Computers and Human Behavior, 21,* 377 – 394.

STUDENTS' ATTITUDE REGARDING USE OF FRAYER MODEL IN THE DEVELOPMENT OF THE COMPREHENSION OF CHEMISTRY CONCEPTS

Silvija Kreile
University of Latvia, Riga, Latvia
E-mail: silviakreile@gmail.com

Abstract

Acquirement of chemistry is connected to cognitive process, where concepts and understanding of those play an important role, which have to be formed already in school. This is where concept mapping comes to be a key element. Frayer model is known as one of graphical organizers for development of the comprehension of concepts. It has not been widely used in Latvia as yet. The goal of this research was to find out what students from secondary and upper-secondary schools think of the Frayer model.

Key words: *comprehension of chemistry, concept, Frayer model.*

Introduction

Acquirement of chemistry as the learning subject is connected to cognitive process in the course of which „concepts are main instruments to reflect substances and their changes in the consciousness of the student" (Gorskis, Rudzitis, 2005).

Concept mapping is known as one of the methods for development of the comprehension of concepts. Concept mapping is not restricted by searching for interconnections between concepts, which is merely one stage in the acquirement of the concepts, it also comprises searching for substance and features of the concepts.

Frayer model elaborated by Doroty Frayer to assess the level of the comprehension of concepts is known as one of concept mapping tools (Frayer, Fredrick, Klausmeier, 1969). It is not well known in Latvia yet. Frayer model could be used to define the concept by own words, to characterize features of concepts (Classroom Cognitive…, 2010), to understand differences between similar concepts, to develop critical thinking, to make the concept visually conformable with own associations (Frayer Model…2015), to acquire new concepts, and to develop connections between new conceptions and already existing ones (Frayer Model…2015). The advantage of the Frayer model, similarly to other methods of the concept mapping, is due to visualization of the concept; the concept is acquired regarding its features.

To elaborate Frayer model, there should be written a key word (concept) in the middle of a page, then this page should be divided in four parts: Part 1- definition, a student should write a definition in his own words; Part 2 – characteristics or facts, which should include characteristics of the concept, features, etc.; Part 3 – an example; Part 4 – a non-conforming example (Frayer Model…2015). Frayer model could be also modified.

Methodology of Research

A research was carried out to find out the attitude of the students regarding the use of Frayer model in the chemistry lessons. The students had not worked with Frayer model before in class. 36 secondary school and 28 upper-secondary school students took part in the research. Answers of all of the respondents were compared and analysed in two groups: G1 – secondary school students (N=36), G2 – upper-secondary school students (N=30). When acquiring the topic, students had to elaborate Frayer model by using a textbook: students of the 10th grade read about structure of atom, whereas 9th grade students read about oxides. Both groups had to form modified Frayer models (9th grade model comprised the following parts: definition, characteristics, example, non-example, but 10th grade – definition, characteristics, picture and example). Afterwards the students had to fill out an inquiry form to find out their attitude regarding the forming of Frayer model. Questions of the query were similar to both groups. Inquiry forms comprised six questions. Questions 1, 3 and 6 had only one choice of answer, whereas questions 2, 4 and 5 had multiple choices.

Results of Research

Regarding the obtained results we can see that forming of Frayer model did not cause great difficulties to the students, as it was recognized by 86,1% of secondary school students (N=21) and 80% of upper-secondary school students (N=24). 37.9% of all respondents (G1 N=13; G2 N=12), recognized that the provided model improved their knowledge about the given concept. Approximately the same number of students – 40.9% recognized that the provided model rather improved their knowledge than not (G1 N=14; G2 N=13), all together it made 78.8% of all respondents. As advantage of Frayer model 68.2% (G1 N=24; G2 N=21) respondents recognize that it is easy to perceive and 57.6% (G1 N=21; G2 N=17) recognize that it helps to learn the given concept. The main problems to the students were caused with tasks where creative approach was necessary – 51.5 % of respondents faced difficulties to make a definition (G1 N=10, G2 N=24), 30.3% (G1 N=8; G2 N=12) problems were raised to find non–example. Less problems were caused by characteristics of a given concept, which as problematic was recognized by 9.1% (G1 N=3; G2 N=3) respondents. It could be explained because it is just a mechanical activity to find information in textbooks. As an advantage of Frayer model 68.2% (G1 N= 24; G2 N=21) students mention easy perception of model, 57.6% (G1 N=21; G2 N=17) think that this model helps them to learn the given concept. In their comments students say that using a provided model makes it more easy to prepare for tests (G2 N=5), as the concept can be better remembered (G1 N=2; G2 N=1).

Conclusions

Frayer model, as one of the graphical organizers for concept mapping is an important tool for the development of comprehension of chemistry concepts, because:

- Forming of Frayer model did not cause great difficulties both to the secondary school and upper-secondary school students;
- Regarding students' self-assessment, it improves students' knowledge about the given concept;
- It develops creative thinking;
- It is easy to perceive and helps students to prepare for tests.

References

Classroom Cognitive and Meta-Cognitive Strategies for Teacher. Research – based Strategies for Problem Solving in Mathematics (2010). Florida Department of Education, Division of Public School and Community Education, Bureau of Exceptional Education and Student Services. Retrieved January 8, 2015, from: http://floridarti.usf.edu/resources/format/pdf/Classroom%20Cognitive%20and%20Metacognitive%20Strategies%20for%20Teachers_Revised_SR_09.08.10.pdf

Gorskis, M., Rudzitis, G. (2005). *General chemistry in the secondary school. Methodical material*. Riga: Zvaigzne ABC.

Frayer, D., Fredrick, W. C., Klausmeier, H. A. (1969). *Schema for testing the level of concept mastery. Report from the project on situational variables and efficiency of concept learning*. Retrieved from: http://brainimaging.waisman.wisc.edu/~perlman/frayer-frederick-klausmeier.pdf

Frayer Model Vocabulary Strategy (2015). Retrieved March 20, 2015, from: http://www.nbss.ie/sites/default/files/publications/frayer_model_-_vocbulary_strategy_handout__copy_3.pdf

THE ROLE OF GAME ELEMENTS IN CHEMISTRY ACQUIREMENT

Emilija Lesina
Ventspils Secondary School No 6, Ventspils, Latvia
E-mail: bjp@inbox.lv

Sandra Kalnina
Ventspils Secondary Evening School, Ventspils, Latvia

Abstract

The method of a game as a tool in teaching Chemistry is described in the paper. The example is given based on a lesson fragment where the elements of a game are used by elementary school pupils who can acquire the skills of using solubility table by learning to compose the formulas of chemical substances. The method allows pupils to understand the structure of substances and secure their skills to use the solubility table practically. Therefore, it is easier to learn Chemistry in the future.

Key words: *chemistry, game as a tool, solubility table, formulas of chemical substances.*

In Latvia Chemistry as a school subject is first offered in the level of elementary school, form 8. At the beginning the pupils grasp Chemistry with great interest, but in the end of form 10 Chemistry is one of the subjects that pupils are not fond of. Chemistry is considered difficult, partly not understandable, and suitable for „specialists” and „strangers”. Therefore, the beginning of learning and teaching Chemistry in form 8 and 9 is essential. One can consider this stage as a crossroad for further interest of Chemistry as well as for making a personal attitude to Chemistry (On the practical..., 2007).

To make interest for learning English, different methods are necessary, particularly those that involve pupils in the cognition process. As a result of pupils' activating and the use of new ways, the specific approach for organizing the educational process is created. This approach is called didactic games.

In Chemistry teaching process the didactic games have been used for a long time. At the end of 1920s quizzes that widen the pupils' view were common in the practice of Chemistry teaching. Practically at the same time the Chemistry lotto appeared. It let not only to increase the interest in pupils, but also to provide more effective Chemistry language acquirement (for example, symbols of elements, formulas of chemical substances etc.). Methodically the games unite several problematic approaches and research approach elements, but according the form the games cover the requirements of organizing seminars and practical workshops.

Nowadays the didactic games are used for preparing pupils for situations that might arise in their lives (Didactic games..., 2014).

The games can also be used to practice the acquired information or to develop the pupils' creativeness, for example, using the games that are connected with the necessity of modelling, imitation and organization. In general, means that can be used in the game are games-exercises, table games, role plays, applied games, plot games, games-answers to the questions etc.

To develop the pupils' skills for using the periodic table of chemical elements and also the solubility table, the playing field is made on the base of the solubility table field that is given in the textbook (Composing of acid..., 2015).

The goal of the use of game elements: to develop skills for using the solubility table of chemical substances. Based on the goal the following tasks are set:

1) modelling of formulas of acid, alkali, and salt by using the game;
2) creating the formulas of different chemicals by using the numeral values of ions' charges from the game field – solubility table;
3) acquiring the chemical structure of acid, alkali and salt, and to be able to distinguish between formulas of acid, alkali and salt.

Necessary materials: previously prepared fields of solubility table, cards with anions and cations, the game programmed on the interactive board

The procedure:

Teacher's activity	Pupils' activity
Gives the field of solubility table and the cards of anions and cations to each pupil.	Pupils put the appropriative cards on the pictures of ions on the sides of the solubility table.
Using interactive board explains how to use the solubility table for composing the formulas of chemical substances. Shows the composing of one acid formula.	Pupils compose the formula by taking the cards from the sides of the solubility table.
According the previous sample, together with pupils makes another formula of chemical substance.	Compose the formula of chemical substance.
Gives the task for pair work to compose the particular formulas and asks to write them down.	Compose the formula of chemical substance by using the cards of ions of the game and write them down in the notebook.
Following the level of pupils' skills, the teacher gradually gives more complicated tasks (For example, if just anions and cations are given, or just by giving the charges of anions and cations.	Compose the formula of chemical substance by using the cards of ions of the game and write them down in the notebook

Therefore, pupils develop the skills of using the solubility table and acquire its structure, and learn to use its structure and information that is given in the table. Thus, it is easier for them to acquire the structure of the table, and they know that on the top of the table there are always the cations, and in the colons – anions are given. It is also easier to grasp visually the sum of the ions' charge. Work in pairs allows pupils to help each other, developing the comprehension of the task.

References

Uz praktisko dzīvi orientētas izpratnes veidošanās ķīmijā [On the practical life oriented comprehension in Chemistry]. (2007). Rīga, Ķīmijas didaktikas centrs, 6. lpp.

Didaktiskās spēles ķīmijas mācīšanā – kāpēc, kad un cik daudz [Didactic games in teaching Chem istry: why, when and how much]. [accessed 25.12.2014.]. Available: http://www.kimijas-sk.lv/index.php/redaktora-sleja/209-2012-gada-9-oktobris

Skābju, bāzu un sāļu ķīmisko formulu sastādīšana [Composing of acid, alkali and salt formula s]. [accessed 20.01.2015.]. Available:http://www.dzm.lu.lv/mat/atbalsts1/stunduPiemeri/kimija/K_08_05_05.pdf

ACQUISITION OF SCIENTIFIC AND PEDAGOGY COMPETENCES BY PRIMARY PRE-SERVICE TEACHERS: MYTH OR REALITY?

Abdeljalil Métioui
University of Québec in Montréal, Montréal, Canada
E-mail: metioui.abdeljalil@uqam.ca

Louis Trudel
University of Ottawa, Ottawa, Canada
E-mail: ltrudel@uottawa.ca

Abstract

In the present research of a qualitative type, we present the results of an experimentation led with 94 pre-service primary teachers from Quebec in Canada. The experimentation, which lasts four months at the rate of three hours per week, took place in two phases. The first phase took place in 4 steps in order to help student teachers to acquire knowledge competency in science and pedagogical knowledge competency, in accordance with the curriculum of the ministry of the education of the government of Quebec. In the second phase, the students had to prepare two teaching sequences centered on laboratory experimentations to the intention of their future pupils of the first, second or third cycle (please note that each cycle lasts for two years). For it, they had to follow an approach similar to the one experienced in the first phase. Finally, they had to complete a questionnaire to specify the difficulties of a scientific or pedagogical nature that they encountered during the conceptions of their teaching sequences. The analysis of the sequences constructed and of the data of the questionnaire shows an effort important on their behalf, in spite of the difficulties they met and that will be presented.

Key words: *training, pre-service teachers, primary school, knowledge competence, pedagogical knowledge competence.*

Introduction

The formation of the primary pre-service teachers in sciences and in technologies is deficient, as several studies have underlined (van Aalderen-Smeets et al. 2011). However, some research works achieved among others in Australia, in Europe and in USA demonstrate that it is possible to correct this situation by offering them a formation allowing them to acquire the basic concepts with the help of the experimentation (Häkkinen & Lundell, 2012). Let's note while the acquisition of these notions is a necessary but not sufficient condition to teach sciences in a non-traditional way. In this approach, the knowledge is transmitted from the teacher to the pupil, as if this last was considered like an empty crock that the teacher would have for task to fill (Bachelard, 1967). Therefore, it would also be necessary that the teacher is capable to manage his course so that his pupils actively participate, which requires from him expertise in didactics and in pedagogy, in addition to sciences. Very few researches in didactics develop strategies related to learning and teaching to allow teachers in formation to acquire these different competences. This exploratory research appears in this perspective.

Objectives of the Formation Program and Description of the Population

In Quebec, teachers' training is the responsibility of the faculties of sciences education and is dispensed over a period of four years. These student teachers are future general practitioners, because they must teach several matters: French, Mathematics, Liberal arts, Sciences and Technologies, etc. Relatively to their scientific formation, they follow a course in didactics of a length of 45 hours (3 credits) spaced out over a period of four months. The majority of the student teachers are possessor of the diploma of collegiate studies in liberal arts (3 years of study after their diploma of secondary studies of a length of five years). Let's note that their formation in sciences is deficient since they only followed a course or two at the time of their secondary studies on basic notions of physics, chemistry and biology. Thus, the course of didactics serves to allow the students to develop disciplinary (science and technology) and professional (pedagogy) expertise as indicated in the program of formation of the Ministry of the education (MELS, 2001).

Methodology of Research

While being inspired by the constructivist approach founded on the hypothesis according to which the learner constructs himself his knowledge, we developed a strategy centered on four aspects: (1) scientific, (2) technology, (3) didactic and (4) pedagogy. With regard to the scientific dimension, we kept the following themes: (1) the states of matter and their physical and chemical transformations, (2) the rectilinear propagation of light, (3) magnetism and (4) the working of simple electric circuits. Let's note that the study of these themes is registered in the curriculum. On the other hand, the curriculum doesn't specify the depth deepening of their studies. For it, we achieved a conceptual analysis to identify the most important notions to study (Métioui and Trudel, 2014). As for the technological aspect, some principles related to the working and the manufacture of some technical objects (thermometer, balance, compass, battery, bulb, multimeter, etc.) has been studied. This survey wanted to underline the interactions that exist between science and technology in the case of the aforementioned themes. Also, the student teachers should know: (1) the objectives pursued by the development of science and technology through different times and in different societies, (2) how the scientists and the technicians of different times proceeded to construct their knowledge and (3) the politics, social and economic factors that influence their development. As for the didactic and pedagogy considerations, they served to incite student teachers to learn how: (1) to guide their future pupils to share and confront their ideas with regard to the natural and constructed phenomena with which they are daily in interaction (2) to identify their conceptions before and after teaching and (3) to bring them to recognize the applicable data in a series of observations done while studying electric and magnetic phenomena in a context of laboratory. While following this training, the student teachers had to build two teaching sequences for pupils centered on experimentation. Every sequence should bear on a theme in the program of formation and should contain the six following stages: (1) initial questionnaire to evaluate the pupil's conceptions before teaching (they had to formulate six questions associated to pupil's environment so that pupil will be tempted to advance some elements of answer), (2) experimentation, (3) scientific notions related to the experimentation, (4) return on the questionnaire of the stage 1, (5) assessment of the pupil's knowledge that follows the experimentations as well the scientific notions studied in the classroom (they had to formulate the questions that oblige the pupil to resort to what he understood and won't be able to answer mechanically) and (6) return on the questionnaire of the stage 5. Finally, they had to complete a questionnaire on their critical analyzes of each of these six stages. For example, we asked them to answer the following question: "What are the difficulties that you encountered to present to the pupil the scientific notions associated with the experimentation in question?"

Results of Research

The questionnaires completed by the student teachers after having followed the formation described before demonstrate that their scientific conceptions on the studied themes evolved, in spite of the time constraint associated with the number of sessions. On the other hand, some false conceptions identified at the time of the administration of the questionnaires before teaching lasted. In this regard, several researches achieved throughout the world show effectively that the conceptual change process in a school context is difficult. As for the teaching sequences elaborated by the students, their analysis reveals that they succeeded in conceiving them, in spite of the multiple difficulties encountered as for example, with regard to the formulation of the initial questionnaire: "The challenge that this stage put me in was to create questions that would not be too difficult for the pupil. I didn't want that he feels discouraged right at the beginning of the project. "; "This part of the sequence was rather arduous to achieve. Indeed, I had the difficulty to find applicable questions on buoyancy." As for the scientific notions, here are some commentaries: "The principle of Archimedes was for me very complicated to explain since before beginning to create this sequence, I didn't have any idea of the existence of this phenomenon."; "I think that the scientific notions were the most difficult part of the approach. It is difficult to explain the condensation, the evaporation, the fusion and the solidification in a simple way so that the pupils can understand."

Conclusion and Implications

The acquisition of competences in sciences and in pedagogy by primary pre-service teachers is altogether a reality since the results of this research demonstrate that they succeeded in conceiving some interactive sequences of teaching, while following a didactic formation in parallel. However, the results of our experimentation reveal that the number of periods dedicated to this formation is not sufficient if one aims to have them conceive their courses so that they are not of simple applicators of recipes who follow to the letter the contents written for them and their pupils in school manuals. Also, it would be necessary that this formation is linked closely to their in schools in order to create a bridge between the school and academic environment.

References

Bachelard, G. (1967). *La formation de l'esprit scientifique*. Paris: Librairie philosophique J. VRIN, 5e Édition Collection: Bibliothèque des textes philosophiques, 257 pages.

Häkkinen, P., & Lundell, J. (2012). Motivating classroom teachers into hands on science experiments in primary school science education. *Abstracts of papers of the 11th European Conference on Research in Chemical Education* (ECRICE): PS2.PO136, 496.

Métioui, A., & Trudel, L. (2014). Conceptual analysis of Quebec primary school programs in Canada: Science and technology. *Journal of Teaching and Education*, *3* (2), 439-446.

MELS (2001). In http://www1.mels.gouv.qc.ca/sections/programmeFormation/pdf/prform2001.pdf

van Aalderen-Smeets, S. I., Walma van Der Molen, J. H., & Asma, Lieke J. F. (2011). Primary teachers' attitudes toward science: A new theoretical framework. *Science Education*, *96*, 158-182.

A FLASH OF CONSTRUCTION SCHEMES COLLECTIVE IN THE CLASSROOM INVOLVING THE FIELD STRUCTURAL MOLECULAR

Marcelo Gouveia Nascimento, Gabriel Nicolas Garcia Alves, Marco Antonio Bueno Filho, Rodrigo Luiz Oliveira Rodrigues Cunha
Federal University of ABC, Santo Andre, Brazil
E-mail: professormarceloquimica@hotmail.com

Abstract

This study aims to access information about how college students collectively build action schemes in structural molecular level. The research had two situations presented to six students and Bachelor Degree in Chemistry from the Federal University of ABC involving content on Liquid Chromatography. The speeches of students organized in groups were recorded in audiovisual and subjected to Textual Analysis Discourse and grounded in the theory of Conceptual Fields (Vergnaud, 1996). The results were assessed, evidence of the collective construction of a scheme characterized by relevant conceptual relationships at the molecular structural field, but incomplete.

Key words: *theory of conceptual fields, collective schemes, chemical bonds.*

Introduction

Understanding the molecular and intermolecular phenomena associated with chemical transformations also pass through the conceptualization of the nature of chemical bonds. Although the difficulties reported in the conceptual framework are known, it is still necessary to deepen on how they suffer advances and setbacks in classroom situations where interaction between individuals is present. This work aims to access information about how a group of students are able to contribute to promoting the conceptual breakthrough in structural molecular field during solving tasks in an experimental teaching sequence.

Methodology of Research

He was offered an experimental course to chemistry students at the Federal University of ABC chromatography. In all, six students participated in the activities and consensually agreed to participate in the study. During the task resolution times audio visual recordings were made and the invitation of the teams to explain how they did, then why did to arrive at its conclusions. After data collection stage, the speeches of the participants were transcribed and submitted to Discursive Textual Analysis (DA) as proposed by Galiazzi and Moraes (2006) with the help of Transana® software (Woods, 2012).

Results and Discussion

At any given time students from different groups were reorganized and invited to work together, student A3 (sucrose challenge) in partnership with students A5 and A6 (challenge of silica). At this time, students evaluated the effectiveness of chromatographic column based on the electronic spectra of the resulting fractions.

A5: chlorophyll and xanthophyll are polar and then they will go out first ... we started with 50:50 hexane and acetone is not it? then the chlorophyll and xanthophyll went down first and then the b-carotene because we reduce the polarity (0:02:15.7)

A3: I think it's like comparing our samples with the literature because the first peak is between 400 nm and 500 nm ... (0:03:08.2)

A6: and these two were the greenest ... (0: 03: 29.0)

The construction of reasoning proceeds in macroscopic terms with the aid of the concept of polarity when A3 brings the data from the column chromatography conducted in sucrose:

A3: so I think it also influences ... (0: 15: 36.8)

A5: flow rate (0: 15: 37.6)?

A3: yes because the particle size of the sugar is greater than that of the silica column ... (0: 15: 44.5)

A5: then had less contact with the sample in the column with stationary phase is not (0: 15: 50.0)?

A3: perhaps because it diminished the polarity of the half made the difference in the experiment ... (0: 17: 00.0)

The comparison between experimental variables becomes more explicit as the student A5 raises the question whether the silica would more polar than sucrose to try to compare the efficacy of different chromatographic columns. A3 contributes to the construction of submicroscopic reasoning to refer to differences in electronegativity between oxygen and silicon atoms, using the teacher to check the validity of the hypothesis.

A5: silica is slightly more polar than sugar? thought it was the opposite being the most polar sugar that silica ... (0: 20: 52.2)

A3: it is that the polarity is linked to the presence of electronegative atoms and groups where oxygen is more electronegative in both cases by comparing the silica with the only sugar that it has similar electronegativity to silicon ... (0: 21: 47.3)

Professor: is a difficult comparison because the two have OH groups ... The silica forms a polymeric structure and sucrose no way ... but compare polarity is difficult because the two are polar structures ... But you have a different variable is granulometry ... (0: 23: 15.2)

The figure 1 shows an overview of the conceptual contents mobilized during the discussion:

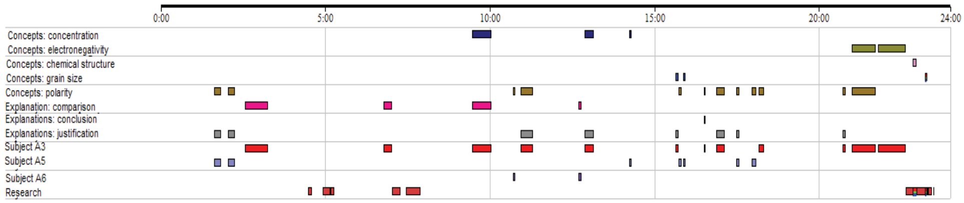


Figure 1: Schematic structure of the students A3, A5 and A6 before and after the teaching approach.

Finally, the data suggest a collective scheme characterized by a conceptual field in motion, where the conceptual relations are provisional and little comprehensive. In the case of the students involved, even though they have often alluded to the effects of polarity and electronegativity (molecular structural field) did not consider nominally and symbolically intermolecular interactions concerning analytes pairs - stationary phase and analytes - mobile phase.

Conclusions

Although the subject chemical bonds and intermolecular interactions are important for the understanding of chemical phenomena it is still a challenge to develop students share schemes where the molecular structural field is instrumental in submicroscopic way to solving tasks. In this direction is the construction of collective schemes and be aware of them for solving tasks in the classroom can be of fundamental importance for decision making in the classroom, especially possible gaps present the conceptual framework schemes and logical operations of thought.

References

Galiazzi, M. C., Moraes, R. (2006). Análise textual discursiva: processo reconstrutivo de múltiplas faces. *Ciência & Educação*, *12*, 1, 117-128.

Vergnaud, G. (1996). Algunas ideas fundamentales de piaget en torno de la didactica. *Perspectivas*, *26*, 1, 195–207.

Woods, C. F. A. D. K. (2012). Transana. In: 2.30B (Ed.). *2.51b*. Madison: *Wisconsin Center for Education Research of University of Wisconsin*-Madison.

EVALUATING THE POTENTIALS OF ICT INTEGRATION IN TEACHING WITH THE AIM OF INTENTIONALLY DEVELOPING COMPETENCIES FOR THE 21ST CENTURY IN PUPILS

Mateja Ploj Virtič, Kosta Dolenc
University of Maribor, Maribor, Slovenia
E-mail: Mateja.PlojVirtic@um.si, kosta.dolenc@um.si

Abstract

With an increasing impact of information and communication technology (ICT) on the way we live and work, the educational institutions also try to transform educational curricula and learning environments in order to fill the technological gap that has emerged in the field of education. This conversion process requires the effective integration of technology into an existing learning environment, and in the first place train the teachers, whose role in the classroom completely changes by introducing technology.

The paper presents an example of integrating innovative pedagogy in the process of future teachers' education and qualitative research, which examines the usefulness of ICT in learning activities for intentional development of competencies for the 21st century learners.

Key words: *ICT, learning activities, learning environment, modern technology.*

Introduction

Education and learning environments have in the last couple of years stared a major change (Dumont, Istance, & Benavides, 2010). At the begging of integrating ICT in schools the focus was on technology, however today pupils and learning are being put into the foreground. Because of technological progress the role of the teacher has changed profoundly. The amount of information is uncontrollably increasing and the knowledge, which until now the teacher passed on his pupils, has become accessible at every step. The pupils can search for information and knowledge with the help of the internet and different on-line applications whenever and wherever. They need to be prepared to critically analyse this data, use it creatively, solve problems, successfully communicate and of course use modern technology. The teachers need to be educated on how to effectively use technologies that would encourage the development of 21st Century competences in their pupils. University professors, therefore, when working with students, pre-service teachers, try to develop in them specific knowledge and skills that will make them cope with their role in the classroom. The article presents a qualitative research that in accordance with various subject fields highlights the usefulness of ICT in developing 21st Century competences in pupils. The research was carried out for the second year in a row with the purpose of monitoring the shift in students' perspective also longitudinally. The results of the research were in 2014 presented at DIVAI 2014 (Ploj Virtič &Pšunder, 2014).

Methodology of Research

The study included seventy 5th year students of the Elementary Education study programme, in 2014/2015 at the Faculty of Education of the University of Maribor.

The students were divided into groups of three and given the task of choosing a study activity with the use of ICT for a subject matter of their choice from the predetermined course syllabus. They had to choose the study activity in such a way, that it systematically facilitated the development of the chosen competence from the list of 21st Century competencies.

Data Processing

Qualitative data processing according to Roblek (2009) was used. Data was collected in the form of presentations of proposals and a semi-structured interview. A systematic review was made on a sample of 24 proposals. This was followed by an evaluation and analysis of the chosen activities for the development of competencies with regards to individual subject fields.

Results of Research

The conducted analysis monitored the types of competencies that the groups of students developed in the pupils with regards to the subject field. The elementary level subjects were combined with the following three subject areas, for which the students proposed the development of the following competencies:

- Mathematics -> 3 x Digital literacy; 1 x Communication;
- Natural Sciences (Environmental Sciences, Natural Sciences and Technology) -> 6 x Digital literacy; 2 x Critical thinking; 1 x Communication and
- Social Sciences and the Humanities (Social Sciences, Slovenian language) -> 4 x Digital literacy; 3 x Communication; 3 x Critical thinking; 1 x Creativity.

Conclusions

The present qualitative study has provided an insight into how pre-service teachers see the possibility of developing pupils' competencies. The study has shown the main differences between various subject fields and the opportunities that these offer in the field of digital pedagogy.

It has been established that, in the subject field of mathematics and environmental sciences, pre-service teachers plan the development of "basic subject-specific competencies" and in the field of social sciences and the humanities also plan for more complex competencies.

The key findings were that pre-service teachers need more practical workshops with hands on experience with new technologies. However, strong relationships need to be fostered between universities and schools to make them both work together so that learning about digital pedagogies can be developed in practical application.

Acknowledgement

This paper is published thanks to the financial support of the project Innovative pedagogy 1:1 in light of 21st Century competences.

inovativna PEDAGOGIKA 1:1

REPUBLIKA SLOVENIJA
MINISTRSTVO ZA IZOBRAŽEVANJE,
ZNANOST IN ŠPORT

Naložba v vašo prihodnost
OPERACIJO DELNO FINANCIRA EVROPSKA UNIJA
Evropski socialni sklad

References

Dumont, H., Istance, D., & Benavides, F. (Eds.) (2010). *The nature of learning, using research to inspire practice.* OECD. Retrieved from http://www.oecd.org/edu/ceri/50300814.pdf

Ploj Virtič, M., Pšunder, M. (2014). Innovative pedagogy: Developing of pupils' competencies through the use of modern technologies in the classroom. In: *10th International Scientific Conference on Distance Learning in Applied Informatics, Štúrovo*, Slovakia, May 5-7, 2014. TURČÁNI, Milan (ur.). *DIVAI 2014: Conference Proceedings*. Prague: Wolters Kluwer, 453-462.

Roblek, V. (2009). Primer izpeljave analize besedila v kvalitativni raziskavi. *Management, 4* (1), 53-69.

THE IMPLEMENTATION OF INFORMATION AND COMMUNICATION TECHNOLOGIES IN SCHOOLS OF LATVIA

Juris Porozovs, Anita Migleniece, Daina Voita, Alvis Valdemiers
Riga Teacher Training and Educational Management Academy, Riga Latvia
E-mail: juris.porozovs@rpiva.lv, daina.voita@rpiva.lv

Abstract

Modern education is closely connected with implementation and using of information and communication technologies (ICT) in the teaching process. The questionnaire of teachers and directors of Latvia schools was carried out in order to evaluate the situation of ICT in schools and the attitude of school pedagogues toward this process. The results of the questionnaire showed that supply of schools with modern ICT in Latvia is not sufficient. The respondents expressed their views: what are the main obstacles of effective implementation of ICT in the study process and what are the priority challenges in the implementation of ICT in schools.

Key words: *information and communication technologies, schools, implementation, teachers, directors*.

Introduction

Nowadays, society is affected by the information and communication technologies (ICT) challenges that come with the Internet network and the World Wide Web (Bouarab-Dahmani, Tahi, 2014). Traditional educational patterns are giving way to more innovative modes and methods of learning, primarily due to radical technological changes that have increased the availability of information and improved communication (Gunn, Hollingsworth, 2013). Schools have an important role in the discovery and learning of the use of these technologies. The successful implementation of changes in the content of education depends on the support of teachers' professional development and innovations in teaching methodology, including extend of using modern information technologies (Izglītības attīstības pamatnostādnes 2014.-2020. gadam, 2014). Every school teacher is faced with the using of ICT in the teaching process, so significant is the opinion of teachers about implementation and use of ICT in schools.

The aim of the work was to investigate the problem of implementation of ICT in schools of Latvia and the attitude of teachers and directors of schools to the using of ICT and implementation of ICT in schools.

Methodology of Research

In order to carry out evaluation of situation of ICT in schools and the attitude of school pedagogues toward this process, the questionnaire of teachers and directors of Latvia schools was carried out. The questionnaire of teachers and directors of the whole country was done using electronic questionnaire, and the questionnaire of Ogre district teachers was carried out using the distribution of questionnaires. 80 teachers (55 from the whole state and 25 from Ogre district) and 28 school directors from the whole state were questionnaire. The majority of the respondents (69%) were of the age 41 to 65.

Results of Research

The results of the questionnaire showed that all the respondents have access to the Internet in schools. This suggests that providing schools with computers is resolved, however it is necessary to continue to improve the qualitative support of schools with ICT.

26% of the questionnaire teachers consider the provision of schools with ICT materials as good or very good, 45% as moderate and 29% as bad. Directors of schools more positively evaluate provision of schools with ICT materials. 43% of directors consider the provision of schools with ICT materials as good or very good, 32% as moderate and 25% as bad. 17% of the questionnaire teachers use ICT in teaching process very intensively – almost every day, 41% use middle intensively – one or several times in a week and 42% of the teachers use several times in two weeks or even more rarely.

The analysis of self-esteem of teachers' computer skills suggests that 26% of the teachers evaluate their computer skills as very good and they can not only successfully work with computer themselves but also help their colleagues to work with ICT if it is necessary. 31% of the teachers evaluate their computer skills as good.

The attitude of teachers to the implementation of ICT in schools characterises also that, how often they promote the using of ICT among students. The using of Internet resources for preparing the lessons regularly promotes 32% of questionnaire teachers. The majority of teachers (65%) promote using of Internet resources only sometimes and so they are not very interested in ICT implementation in the study process. 3% of the questionnaire teachers accept that they don't promote using of Internet resources for preparing the lessons.

71% of teachers and also 71% of directors fully or partially support the contention that it is necessary to use more ICT in the study process for creating a learning environment for independent work of students. However, 29% of directors partially or completely don't agree with this statement and it raises the concern that implementation of ICT in many schools will not be stimulated. 50% of directors and 68% of teachers fully or partially agree with the statement that it is possible to improve the achievements of students by using more ICT. Directors are less optimistic as teachers to this consideration. 66% of the respondents (57% of directors and 69% of teachers) fully or partly agree with the assertion that ICT could help teachers to adapt to the learning style of some students.

64% of the respondents (54% of directors and 69% of teachers) fully or partly agree to the consumption that ICT improve the possibilities of controlling students in the study process. School directors on who in a great extent depend implementation of ICT in the study process and the attitude of school collective to the using of ICT again is more skeptical. 62% of the respondents as the main obstacle for the implementation of ICT in the study process and using in the lessons indicate the lack of skills of teachers in the field of ICT. As the other significant obstacles for using ICT the teachers consider the lack of teaching materials and insufficient number of computers, outdated equipment, the teacher's lack of interest in using ICT and the lack of a unified system of implementation and management of ICT in schools.

The majority of teachers (81%) consider that the effective measure for improvement of using ICT is the promotion with the computer of every teacher. As the other effective measures the teachers consider: acquisition of more modern technologies for schools, increase of teacher's interest in ICT and teachers' training in the field of ICT.

Conclusions and Implications

Supply of schools with ICT is not sufficient. ICT is not available for effective work in a necessary set. It is necessary to raise the competence of teachers in the work with ICT. The main obstacles for the implementation of ICT in the study process are the lack of skills of teachers in the field of ICT, insufficient supply of schools with ICT, insufficient number of computers, outdated equipment, the attitude of directors to the implementation of ICT in schools, lack of interest of teachers in using ICT and the lack of a unified system of implementation and management of ICT in schools.

The priority challenges in the implementation of ICT in schools are: acquisition of qualitative ICT teaching materials and computers in schools, promotion of every teacher with computer, the training of teachers in the field of ICT, inclusion of ICT methods in the learning programmes and thematic plans of subjects, the raising of teacher's interest in the using of ICT, the application of a unified system of implementation and management of ICT in schools.

References

Bouarab-Dahmani, F., & Tahi, R. (2014). New horizons on education inspired by information and communication technologies. In Isman, A. (Ed.) *International Conference on New Horizons in Education, INTE 2014, 25-27 June 2014, Paris, France* 602-608. doi: 10.1016/j.sbspro.2015.01.589.

Gunn, T. M., & Hollingsworth, M. (2013). The implementation and assessment of a shared 21st century learning vision: A district-based approach. *Journal of Research on Technology in Education, 45* (3), 201-228. Retrieved from http://www.tandfonline.com/doi/abs/10.1080/15391523.2013.10782603#.VTUTAyGqpBc

Izglītības attīstības pamatnostādnes 2014.-2020. gadam. Retrieved April 10, 2015, from http://m.likumi.lv/doc.php?id=266406

DISCUSSION OF VISUAL ATTENTION FOR SOLVING MULTIPLE CHOICE SCIENCE PROBLEM: AN EYE-TRACKING ANALYSIS

Miroslawa Sajka, Roman Rosiek
Pedagogical University of Cracow, Poland
E-mail: msajka@up.krakow.pl, rosiek@up.krakow.pl

Abstract

Eye-tracking technology was used to analyze the participants' visual attention while solving a multiple-choice science problem. The research encompassed 103 people of varying levels of knowledge, from pupils to scientists. The respondents in general devoted more time to analyze the chosen fields. However, the trend is reversed for people with high scientific expertise and criticism and with extreme motivation to solve a problem. The trend depends also on the strategies of solving a problem and conviction about the correctness of the answer.

Key words: *eye-tracking, mathematics and physics education, problem solving, new technology in didactics of science.*

Introduction

The use of eye-tracking technology for analysis of the learning process has become more and more widespread in recent years. The use of such modern methods has already lived to see even partial summaries. Lai et al. (2013) reviewed, for example, 81 papers dedicated to the use of eye-tracking technology in research related to the analysis of the learning process, describing 113 studies carried out in years 2000 to 2012.

One of them was the article written by Tsai et al.(2012), where the responses of 6 male university students over a multiple-choice task with more than one correct answer were analyzed. The authors posed four hypotheses and positively verified all of them. The aim of our research is to verify the following two of them: "Students, in general, spent more time inspecting their chosen options than rejected ones (H1)" and "Successful problem solvers inspected the options in a different pattern from unsuccessful problem solvers (H3)."

The presented research, however, differs in the following numerous assumptions and circumstances:

1. The first obvious difference concerns the language, culture and the scope of the studied educational content between the experiment participants from Taiwan and Poland. It is worth checking whether the conclusions reached by scientists from another continent are universal, or whether they are conditioned by other factors.

2. Tsai et al. (2012) positively verified the hypotheses for 6 people. The presented research used a much greater group of 103 subjects. This allows us to analyze the data in a quantitative way.

3. The respondents in the experiment of Tsai et al. (2012) were university students. The presented research sample is diverse due to the age and scientific experience of participants. It includes both experts - scientists with PhD degrees in one of three areas: physics, mathematics and computer science; PhD students of physics, and university students of physics, mathematics, computer science, and biology as well as 2nd grade high school students.

4. The final difference relates to the problem used in the experiment. Although it is also a multiple-choice problem, the research task concerns physics and mathematics.

The following research questions were posed:

1 (a). Do the respondents generally devote more time for analyzing their chosen answers, considered by them to be correct, than to analyzing the rejected responses? What is the general trend?

1 (b). Are there significant differences in the general tendency for participants of various scientific expertise: experts, students and pupils?

2. Do successful problem solvers inspect the options in a different pattern from unsuccessful problem solvers?

Methodology of Research

People of varying levels of knowledge and skills in mathematics and physics participated in the study. The size of the research sample allowed us to analyze data both in a qualitative and a quantitative way. The respondents were to solve one problem in mathematics and physics, which was a science multiple choice task. To record the study participants' eye movements the eye tracker iView X™ Hi-Speed 1250 was used. The sampling rate was set to 500 Hz, monocular. The data obtained in the experiment were processed by BeGaze software.

The eight *Areas of Interest* (AOI) were defined. Among them were wording of a problem and graphs and the answers (statements) A, B, C, D ,E. The *dwell time* and *time of fixation* were examined. The analysis was supported by the individual analysis of *scan paths* and *heat maps* (of fixations). We analyzed the consolidated data for all examined people as well as data for the groups of different knowledge advancement (experts, students, pupils), and also individually.

Results of Research

The results of our experiment on a sample of 103 people confirmed that subjects in general devote more time to analyze the responses chosen, considered by them to be correct, than to analyze answers rejected. That conclusion can be drawn on the basis of the average percentage *dwell time.*

However, the conclusion changes its power when we analyze the data individually. The individual analysis of all data, carried out from the point of view of knowledge and experience in physics and mathematics provides other interesting conclusions.

Among the experts *dwell time* for the selected answer was maximal only for one person. The group of experts, who were professionally active researchers, differed significantly from the other participants of the study. There is meaningfully different not only subject matter knowledge and experience in this group, but also the level of motivation to properly solve the task, the level of criticism of their own work in order to avoid errors and the level of responsibility for the result of their work. The hypothesis can be posed that for people with very high motivation to solve a problem properly and high scientific expertise the tendency is reversed. These characteristics cause a type of strategy.

The next observation made is that the reversed tendency appeared when the participants were uncertain of their knowledge or choice, which was visible while analyzing the video *scan path* and confirmed by them. In a group of physics students e. g., the chosen answer is the one with the longest *dwell time* and the same we observe for all the high school students. Their knowledge on that matter was much perpetuated.

Additionally, all school students as well as mathematics and biology and computer science students who improperly pointed the answer but put an effort to solve them, reached maximum of dwell time for that field.

In the opposite, for computer science students, who were not motivated to make an effort to solve the problem, the reversed tendency was observed.

Conclusions and Implications

The study participants who analyzed the chosen field the longest, took an effort to solve a problem using their knowledge and were adequately motivated to solve the problem. The lack of the one of the factors caused the reverse tendency for the participants of the study. It was observed for example for people with not enough subject matter knowledge to make an effort to solve the problem or for people with non-adequate motivation: very poor or huge, like for experts.

On the basis of the research the following hypothesis could be posted. The general tendency of staying the longest time in the field of the chosen answer can be an indicator of taking an effort to solve a problem using knowledge and having at the same time adequate motivation. It is worth to verify the hypothesis using not only large samples of participants, but also using together with eye-tracking other research methods, monitoring physiological parameters like blood volume pulse, skin conductance or even using EEG.

References

Lai, M. L., Tsai, M. J., Yang, F. Y., Hsu, C. Y., Liu, T. C., Lee, S. W. Y., … Tai, C. C. (2013). A review of using eye-tracking technology in exploring learning from 2000 to 2012. Educational Research Review, 10, 90-115.

Tsai, M. J., Hou, H. T., Lai, M. L., Liu W. Y., & Yang F. Y. (2012). Visual attention for solving multiple-choice science problem: An eye-tracking analysis. Computers & Education, 58, 375-385.

DESIGNING A BLENDED LEARNING ENVIRONMENT TO SUPPORT SELF-DIRECTED AND SELF-REGULATED LEARNING

Aysan Şentürk
Uludag University, Turkey
E-mail: aysan@uludag.edu.tr

Abstract

In this study, a blended learning environment was designed for sixty students from Computer Education and Instructional Technologies Department, taking Programming Languages course. The environment was designed to support self-directed and self-regulated learning. Interviews with open ended questions were used as data collection instruments. According to the qualitative data collected in this study it was concluded that students were satisfied using that learning environment.

Key words: *blended learning environment, self-directed and self-regulated learning, university students*.

Introduction

Blended learning is one of the frequent concepts which have been included in the studies that aim to make use of technology in recent educational activities. One of the widespread definitions of blended learning is that it is the combination of traditional face-to-face teaching and online teaching (Osguthorpe & Graham, 2003; Williams, 2002). According to a similar definition made by Garrison and Kanula (2004), blended learning is the integration of the strong parts of traditional face-to-face teaching and internet based teaching, and the joint use of them in a learning environment. Blended learning includes not only learning environment, but also the collaborative use of different teaching methods to increase the learning outputs (Clark & Mayer, 2011).

Self-regulation is one of the crucial concepts covered in Bandura's social learning theory. According to Bandura (1977), people mostly regulate their behaviours on their own. Self-regulation is monitoring one's own behaviours, making judgements by comparing them with their own criteria and accommodating them appropriately, if needed (Senemoğlu, 2005). To Pintrich (2000) self-regulation is an active and constructive process where learners determine their learning objectives and regulate their cognitions, motivations and behaviours. In this process, individuals are regulated by their objectives and the context which they are in. In short, self-regulation is one's impact, guidance and control of their own behaviours (Senemoğlu, 2005).

On the other hand, self-directed learning is a process which requires individuals to determine their own learning needs and to choose appropriate learning strategies accordingly (Knowles, 1975). This process necessitates individuals to make decisions towards what to learn, which methods or materials to use and how to measure their success. It also includes determining objectives, finding relevant materials and evaluation of results. Therefore, it would be wise to infer that self-directed learning is related to one's own control of their learning and taking responsibilities.

In this study, a blended learning environment was designed to support self-directed and self-regulated learning.

Methodology of Research

Sixty students taking Programming Language course at Computer Education and Instructional Technologies Department (CEIT) participated in this study. Qualitative data analysis method was used in the study. A data collection instrument that contains open ended questions was developed and applied to the participants after taking expert opinion.

Conclusions

The analyses made on the qualitative data revealed and supported that the designed learning environment was successful to improve self-regulated and self-directed learning skills of the learners. Students remarked that the rich content in the learning environment, the easy accessibility of the environment and the guidance to lead students solving problems through researching increased their participation in the course. Moreover, they remarked that the environment encouraged them to develop strategies to be successful in the course. Because it gave feedback on learning levels and showed their weaknesses as well as being in a flexible form. They also commented that the same learning environment increased their motivation. Blended learning environment which is designed according to the students has many advantages compared to traditional learning environment. For example, students commented that the blended learning environment forced them to do research, made them have competence over the topic with repetitive use of the course materials and made them take individual decisions towards the learning process. Students also emphasized that they can get assistance from friends and instructor with the help of communication opportunities offered in a blended learning environment. They also made some suggestions for improving the learning environment, such as the involvement of different experts in the environment, providing more research projects and the increase of more video courses as well as their quizzes and practice questions.

References

Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review, 84* (2), 191-215.

Boekaerts, M., Pintrich, P. R., & Zeider, M. (2000). Self-regulation: An introductory overview. In M. Boekaerts, P. R. Pintrich & M. Zeider (Eds.), *Handbook of self-regulation* (pp. 1-9). San Diego, CA: Elsevier Academic Press.

Clark, R. C., & Mayer, R. E. (2011). *E-learning and the science of instruction: Proven guidelines for consumers and designers of multimedia learning*. San Francisco, CA: Pfeiffer.

Garison, D. R., & Kanula, H. (2004). Blended learning: Uncovering its transformative potential in higher education. *Internet and Higher Education, 7*, 95-105.

Osguthorpe, R. T., & Graham, C. R. (2003). Blended learning environments definitions and directions. *The Quarterly Review of Distance Education, 4* (3), 227-233.

Pilling-Cormick, J., & Garrison, D. R. (2007). Self-directed and self-regulated learning: Conceptual links. *Canadian Journal of University Continuing Education, 33* (2), 13-33.

Pintrich, P. R. (2000). The role of goal orientation in self-regulated learning. In M. Boekaerts, P. R. Pintrich, & M. Zeidner (Eds.), *Handbook of self-regulation* (pp. 451–502). San Diego: Academic Press.

Senemoğlu, N. (2005). *Gelişim, Öğrenme ve Öğretim: Kuramdan Uygulamaya*. Ankara: Gazi Kitabevi.

Williams, C. (2002). Learning on-line: A review of recent literature in a rapidly expanding field. *Journal of Further and Higher Education, 26* (3), 263-272.

THE ROLE AND SCOPE OF VISION THERAPY IN EDUCATIONAL PRACTICE

Violeta Šlekienė, Loreta Ragulienė
Siauliai University, Lithuania
E-mail: violeta@fm.su.lt, loretar@gmail.com

Abstract

The efficiency and quality of the vision is one of the key challenges of a modern life. The goal of the paper is to reveal a need of vision therapy and preventive vision improvement in a general education school. The aim of vision therapy is to improve vision and efficiency of the vision and to find ways to further improve quality of vision. Vision therapy is usually individually tailored to each and every person in order to clarify the issues. Worldwide, doctors caring for patients' vision, lots of attention devote for improvement of eye prophylaxis treatment during special training. Vision therapy is used to address these issues: insufficiency of accommodation, problems of presbyopia and amblyopia, convergence or divergence, dyslexia, after Strabismus surgery and others. Permanent eye exercise not only improves vision, but also prevents the eyes from harmful effects of environment.

Key words: *science education, vision, vision therapy*.

Introduction

The efficiency and quality of vision is one of the key challenges of a modern life. The quality of vision is the most important aspect in any human activities, such as training, work, recreational sports etc. Performance of our visual system affects learning skills. Ineffective vision may lead to a slowdown in an activity; a man will be less accurate, would suffer excessive fatigue or make more mistakes. Any visual disturbances may affect the accuracy, awareness and understanding speed of the information. The human visual system is a complex mechanism. The problems which could arise in our visual system often require complex solutions. Most of the neurological abnormalities may be effectively corrected with properly chosen glasses or contact lenses. However, a number of visual impairments are effectively corrected with vision therapy. (Vision therapy. http://www.aoa.org/optometrists/education-and-training/clinical-care/vision-therapy). Vision therapy consists of a wide range of programs that improve vision. It covers the eye care and treatment, eye movement and binocular vision problems. Optometrists are working in this area (Press Leonard J., ed., 1997). Research carried out by scientists proves the efficiency of ortooptics or vision therapy to improve the quality and effectiveness in different aspects. Individually selected and properly applied vision therapy helps to overcome insufficiency of accommodation (Suchoff I.B., Petito G.T., 1986), binocular anomalies (Griffin, J.R., & Grisham, J.D., 2002), heals the convergence insufficiency of teenagers (Scheiman M. et al., 2005), reduces oculomotor consequences of acquired brain injury of adults (Ciuffreda K.J., Han Y., et al., 2001; Ciuffreda, K.J. et al., 2008), improves pupils' reading skills (Seiderman A.S., 1980, Goss D. A., et al., 2007), etc. The goal of the paper is to reveal the need of vision therapy, and preventive vision improvement in a general education school.

Vision Improvement Methodology

There are many non-medicinal methodologies for vision improvement. Vision improvement methodologies are usually published in individual brochures and books. About damage and danger of spectacles more than a hundred years ago said a known ophthalmologist and a scientist *William Horatio Bates* from New York. His book " *Beitso metodas regėjimui pagerinti be akinių*" (1996), *Better Eyesight without Glasses* (2008) was published all around the world. W. H. Bates brought truly revolutionary approach to the treatment of refraction anomalies. Causes of the vision anomalies, treatment approaches and exercises are analyzed in the book.

The recent Lithuanian bookstores have reached therapeutic exercise book prepared in the American Institute of Vision: S. M. Beresford D. W. Muris M. J. Allen F. A. Young (2000). *Kaip gerinti regėjimą be akinių ir kontaktinių lęšių* (*How to improve vision without glasses or contact lenses*,1996). There is a lot of theoretical and practical advice. The book provides information about eye diseases, retinal anatomy, and many prophylactic things for keeping good eyesight. The book offers suggestions on how to improve vision without a lot of effort, how to wean ourselves off corrective spectacles, how to learn to see with one's own eyes.

One of a handful of Russian ophthalmologists, recognizing the futility glasses is O. Pankovas. In his book "*Glasses murderers*" (Панков,2006) he stated on the hazard of "optical crutch" to the eye and the whole organism. His main argument against glasses is that glasses don't allow ultraviolet radiation, whose 80 percent to our body falls over the eyes to reach the eye.

The director of the centre of natural restoration and enhancement of eyes health Svetlana Troickaja based on her personal and professional experience suggests that, systemic approach is required in order to improve vision. Systematic approach to eye health restoration and enhancement (2008) has been described by S. Troickaja in the book *"Atsikratykite akinių-žudikių visiems laikams"*.

The M. S. Norbekov - a medical doctor of psychology, pedagogy and philosophy, professor of Russian and foreign academies, the founder and the president of the "Institute of self recovery of humans" has developed a unique learning - wellness system. His unique system was described in the book "Kvailio patirtis, arba kelias į praregėjimą" (Norbekovas, 2010). The book became a bestseller; it is not only an instruction that helps to achieve faster recovery of vision, not just a philosophical treatise for chronic patient - looser, but rather a guide for action.

Conclusions and Implications

All vision therapy techniques are not medical. It's more like psychological-educational methods. Prophylaxis and vision therapy are primarily used all around the world by psychologists and educationalists not doctors. There is no healing in improving person's vision, it is teaching. Eyes are the same part of the human body as other parts, and you should take care and rest.

Pupils' education on eyes care should be one of the tasks of general education schools. Attention needs to be paid to the quality of pupils' vision at school. There must be time to develop pupils' need to take care of our own vision. School's community should decide during which classes and lessons vision therapy should be done. The starting point should be at kindergarten or in primary school. The sooner children adopt appropriate eye care skills, the more it becomes a habit and the less valuable time will take in older age. It is important for students to learn to love their eyes, remember to take care of them, to rest and relax them.

Exercises for eyes should be prepared and given to pupils as their obligation for the eyes. The memos should be included with: relaxation exercises, solarization, massages, imaginational exercises, exercises for eyes muscles and for accommodation.

References

Bates, W. H. (1996). *Beitso metodas regėjimui pagerinti be akinių*. Narbuto leidykla, Šiauliai.

Bates, W. H. (2008). *Better eyesight without glasses.* Orient Paperbacks, UK, p. 232.

Beresford, S. M., Muris, D. W., Allen, M. J., Young, F. A. (2000). *Kaip gerinti regėjimą be akinių ir kontaktinių lęšių: Amerikos regos instituto terapinių pratimų naujoji programa*. Iš anglų kalbos vertė Tamūnas, L. Vilnius: Alma littera.

Beresford, S. M., Muris, D. W., Allen, M. J., Young, F. A. (1996). *Improve your vision without glasses of contact lenses.* Paperback, UK.

Ciuffreda, K. J., Han, Y., Kapoor, N., et al. (2001). Oculomotor consequences of acquired brain injury. In: Suchoff I.B., Ciuffreda K.J., Kapoor N. (Eds.), *Visual and vestibular consequences of acquired brain injury*. Santa Ana, CA: OEP Foundation, 77-88.

Ciuffreda, K. J., Rutner, D., Kapoor, N., Suchoff, I. B., Craig, S., & Han, M. E. (2008). Vision therapy for oculomotor dysfunctions in acquired brain injury: A retrospective analysis. *Optometry-Journal of the American Optometric Association*, *79* (1), 18-22.

Goss, D. A., Downing, D. B., Lowther, A. H., Horner, D. G., Blemker, M., Donaldson, L., … & Gray, K. H. (2007). The effect of HTS vision therapy conducted in a school setting on reading skills in third and fourth grade students. *Optometry & Vision Development*, *38* (1).

Griffin, J. R., & Grisham, J. D. (2002). *Binocular anomalies: Diagnosis and vision therapy*. Butterworth-Heinemann Medical.

Norbekovas M. (2010). *Kvailio patirtis, arba kelias į praregėjimą*. Vertėjas: Parulskis, S. Vilnius: Alma littera.

Press, L. J., ed. (1997). *Applied concepts in vision therapy with accompanying disk*. Mosby Incorporated.

Scheiman, M., Mitchell, G. L., Cotter, S., et al. (2005). A randomized clinical trial of vision therapy/orthoptics versus pencil pushups for the treatment of convergence insufficiency in young adults. *Optometry & Vision Science, 82*, 583-95.

Seiderman, A. S. (1980). Optometric vision therapy – results of a demonstration project with a learning disabled population. *Journal of the American Optometric Association*, *51* (5), 489-493.

Suchoff, I. B., Petito, G. T. (1986). The efficacy of visual therapy: accommodative disorders and non-strabismic anomalies of binocular vision. *Journal of the American Optometric Association*, *57*, 119-125.

Troickaja, S. (2008). *Atsikratykite akinių-žudikių visiems laikams.* Logitema.

Vision therapy. http://www.aoa.org/optometrists/education-and-training/clinical-care/vision-therapy

Ždanov, V. (2010). *Susigražink sau regėjimą*. Retrieved from www.nlpcentras.lt/.../susigrazink-sau-regejima-v-zdan (10 May 2015).

Панков, О. (2006). *Очки убийцы.* Москва: Издательство Метафора, 240 стр.

DEVELEPMENT OF COMPUTER-BASED EDUCATIONAL GAME ACROSS COMPUTER SCIENCE CURRICULUM

Dzintars Tomsons, Inta Znotiņa
Liepāja University, Liepāja, Latvia
E-mail: dzintars.tomsons@liepu.lv

Abstract

The current paper describes the use of game development for improvement of first year Computer Science students' professional and social competencies. The computer-based education games play grateful platform for integration of knowledge and skills gained by students in several learning courses, i.e., programming, web-design, computer graphics and animation, introduction to software engineering, etc. The multidisciplinary character of the games provides possibilities to constitute teams with students from different study programs. Thereby the students get their first experience in cross-disciplinary communication.

Key words: *computer-based education, educational games, learning environment*.

Introduction

Digital games have received interest from academic staff for their capacity to improve learning. (Akcaoglu & Koehler, 2014). Learning applies game technologies as part of the learning experience (Bourbia et al., 2014). Games are known for learners, they are fun and entertaining. Mixed with learning material, educational games can attract learners to play (and learn) and to remain engaged until the learning objectives have been achieved (Yusoff et al., 2009). While game play may offer significant learning opportunities, educational game construction has been identified as a student-centred constructivist-approach in educational improvement (Baytak & Land, 2011).

Most of the students are familiar with computer-based games, and they can express their creativeness and initiatives during the game development (Yusoff et al., 2009). Developing the computer-based educational game project, students have the following assignments – defining idea for game scenario, its agreements with teammates and presentation, studying of state-of-the-art, identification of several alternative solutions and selecting the most suitable one, software development, and presentation of an intermediate and final version of the game and its documentation.

The development of computer-based educational game provides a powerful learning environment to foster active, self-directed learning supported by rich context and authentic tasks of composition and construction (Robertson & Howells, 2008). The development of educational game requiring content application can be applied as a *microworld* in which learners must explore, represent, and test their domain knowledge and skills and integrate them into the game design (Mitchell et al., 2007).

Game development provides a platform for training soft skills, such as teamwork, verbal and written communication, time management, problem solving, critical reasoning, creative thinking, and flexibility, that play a critical role in the workplace, and that are important for promoting successful professional practice in a variety of career paths (ACM/IEEE-CS, 2013).

Based on the above rationales the current research study addresses the following research questions: (Q1) Has development of computer-based educational game positive effect on learning outcomes of software engineering courses? (Q2) Does development of computer-based educational game provide better understanding of the common integrated foundation of different separately learned software development courses?

Methodology of Research

In order to carry out the empirical analysis, 24 students from Liepāja University were selected and grouped into 8 project teams, i.e., 3 members in each team, among the first year Computer Science and Information Technology undergraduates. One or two New Media Art students joined each team, too. The study project provides possibilities for the Computer Science students to apply knowledge and skills of programming, web-design, computer graphics and animation, and multimedia learned in separate courses. The students learning activities have been supported by Course Management System (CMS) Moodle.

The research study is based on analysis of Moodle log file data describing user behaviour in a virtual learning environment and individual learning performance. In addition, self-evaluation surveys and informal interviews have been conducted to get answers to the research question defined above. The detailed description of the research results will be provided in the authors' presentation.

Conclusions and Implications

The results of the current research provide methodological support for the use of game design as a meaningful context to teach students generic skills. Computer games are useful learning and teaching tools for common understanding of the complexity of software development and for getting the first experience of software development. The experience got during the development of the educational computer-based game serves as a pre-requisite for meaningful learning of advanced software engineering courses.

The findings of the current study indicate improvement of skills of team working, communication, and problem-solving. Teamwork activities have been playing a more essential role in Computer Science curriculum because of corresponding demand in the labour market. Due to cross-disciplinary character of computer-based educational games, the corresponding software development projects provide complementary experience working in heterogeneous team.

References

ACM/IEEE-CS Joint Task Force on Computing Curricula (2013). *Computer Science Curricula 2013*. ACM Press and IEEE Society Press. Retrieved from: http://dx.doi.org/10.1145/2534860.

Akcaoglu, M., Koehler, M. J. (2014). Cognitive outcomes from the Game-Design and Learning (GDL) after-school program. *Computers & Education, 75,* 72–81.

Baytak, A., Land, S. M. (2010). A case study of educational game design by kids and for kids. *Social and Behavioral Sciences*, *2* (2), 5242–5246.

Bourbia, R., Gouasmi, N., Hadjeris, M., Seridi, H. (2014). Development of serious game to improve computer assembly skills. *Social and Behavioral Science*s, *141*, 96 – 100.

Mitchell, J., Kelleher, H., & Saundry, C. (2007). A multimedia mathematics project in a teacher education program. In L. Farr Darling, et al. (Eds.), *Collective improvisation in a teacher education community* (pp. 101–118). Springer Science Business Media.

Robertson, J., Howells, C. (2008). Computer game design: Opportunities for successful learning. *Computers & Education*, *50* (2), 559–578.

Yusoff, A., Crowder, R., Gilbert, L., Wills, G. (2009). A conceptual framework for serious games. In *Proceedings of the Ninth IEEE International Conference on Advanced Learning Technologies* (pp. 21-23). IEEE Computer Society.

DEVELOPMENT OF SCIENCE TEACHER CREATIVITY AND IBSE

Eva Trnova, Josef Trna
Masaryk University, Brno, Czech Republic
E-mail: trna@ped.muni.cz

Abstract

Teacher creativity is essential for development of students' creativity. Creation of methods for development of teacher creativity, as a part of teacher education, is a necessity. Within project PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) we discovered that an effective method of development of science teacher creativity is a training of teachers in implementation of IBSE. Styles of teacher creativity were studied using Kirton's Adaptation-Innovation Inventory. Levels of creativity were identified by a case study.

Key words: *creativity, development, IBSE, science education, teacher education.*

Introduction

Creativity plays a very important role in education as relevant competency for the 21st century (Rocard et al., 2007). According to the findings of experts, teacher creativity is important for the development of student creativity (Sternberg, 1999; Amabile, 1996; Gryskiewicz, 1982). Most of teacher creativity is manifested in teachers' creative work with the subject content as a creative didactic practice (Barbot, Besançon, & Lubart 2011). Through their own creativity, teachers affect creativity development of their students. Creative education is an intentional activity, with specific methods and setting conditions to make these methods effective. Creativity is a crucial factor in the multidimensional development of teacher professional competences.

Rationales

It is necessary to introduce a theoretical base of creativity and its development. Based on our research, inquiry-based science education (IBSE) seems to be the appropriate way for development of teacher and student creativity because it enables individual attitudes in the development of creativity (Jeffrey &Craft, 2004). The principles of IBSE as student activities, meaningful contexts, critical thinking, etc. correspond to core characteristics of creativity. IBSE also involves basic processes that support development of creativity. The main objective of our European 7FP project PROFILES (Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science) is to promote IBSE as a component of teaching/learning and continuous professional development (CPD) of teachers-participants, who go step by step through this CPD programme to develop their professional knowledge and skills as well as creativity.

Research Question and Methods

The research question was phrased as follows: *Has there been development of teacher creativity involved in PROFILES CPD programme based on implementation of IBSE?* The subjects were 50 science teachers of secondary schools in the Czech Republic - participants in the PROFILES CPD programme in 2011-2013. We used standardized method Kirton's Adaptation-Innovation Inventory (KAI) to study styles of teacher creativity (Kirton, 1994). Torrance tests (Torrance, 1974) or variants of them were used for measuring the level of creativity. The retrospective case study was used for descriptive and explanatory analysis of teacher-participants of PROFILES CPD programme in the PROFILES project. This case study is a type of a key-study (the most important characteristics of the subject are presented) and have these characteristics: exploratory purpose, illustrative approach, and multiple processes.

Results and Discussion

We have discovered significant creativity development of teachers-participants of PROFILES CPD programme. According to our findings, IBSE (Banchi & Bell, 2008) is a suitable method for development of teacher and student creativity. There is an overlap between factors supporting creativity and core principles of IBSE (Trnova & Trna, 2012). Creating new curricular materials for IBSE (modules) was a comprehensive expression of increase of the teachers' creativity level. According to our observation, content analysis of data and structured interviews, each participant improved in accordance with the definition of creativity his/her abilities (participants created new materials etc.), individual approach (teachers changed worksheets etc.) and process (teachers worked very hard etc.). Styles of teacher creativity were determined by using the KAI inventory. The theoretical measurement interval is between 32 and 160 points. The points of teachers-participants of the study were between 102 and 132 - all scores of the Czech teachers were higher than the average score (96) presented in literature. Their average score was 113.8.

Conclusions and Implications

We can conclude that Czech science teachers-participants of PROFILES CPD programme shows development of their creativity. The retrospective case study of selected teacher-participant of CPD in the PROFILES project study confirmed a significant increase in the level of teacher creativity (Trnova, Kopecka, & Trna, 2014). The answer to our research question is positive. Participation of teachers in the PROFILES CPD programme based on implementation of IBSE led to the development of their creativity. Development of teacher creativity should become an important objective for their pre-service and in-service education.

Acknowledgement

This paper is published thanks to the financial support of the project Nr. FP7-SCIENCE-IN-SOCIETY-2010-1, 266589 named: “PROFILES: Professional Reflection-Oriented Focus on Inquiry-based Learning and Education through Science“.

References

Amabile, T. M. (1996). Creativity in context. Boulder, CO: Westview.

Banchi, H., & Bell, R. (2008). The Many Levels of Inquiry. Science and Children, 2, 26-29.

Barbot, B., Besançon, M., & Lubart, T. (2011). Assessing creativity in the classroom. The Open Education Journal, 4, 58-66.

Gryskiewicz, S. S. (1982). Creative leadership development and the Kirton adaption-innovation inventory. Paper presented at the Occupational Psychology Conference of the British Psychological Society, Brighton, England.

Jeffrey, B., & Craft, A. (2004). Teaching creatively and teaching for creativity: Distinctions and relationships. Educational Studies, 30 (1), 77-87.

Kirton, M. J. (1994). Adaptors and innovators: Styles of creativity and problem- solving. London: Routledge.

Rocard, M., Cesrmley, P., Jorde, D., Lenzen, D., Walberg-Herniksson, H., & Hemmo, V. (2007). Science education NOW: A Renewed Pedagogy for the Future of Europe. Brussels: Office for Official Publications of the European Communities. Retrieved February 15, 2015, from http://ec.europa.eu/research/science society/document_library/pdf_06/report-rocard-on-science-education_en.pdf.

Sternberg, R. J. (1999). Handbook of creativity. Cambridge: Cambridge University Press.

Torrance, E. P. (1974). The Torrance Tests of Creative Thinking-Norms-Technical Manual Research Edition-Verbal Tests, Forms A and B- Figural Tests, Forms A and B. Princeton: Personnel Press.

Trnova, E., Kopecka, N., & Trna, J. (2014). Science teacher.-leader: Role of creativity in the multidimensional development of a teacher's professional competence. In C. Bolte, J. Holbrook, R. Mamlok.-Naaman, & F. Rauch (Eds.). Science Teachers' Continuous Professional Development in Europe. Case Studies from the PROFILES Project. (pp. 207.-219). Klagenfurt: Freie Universität Berlin/Klagenfurt: Alpen.-Adria.-Universität Klagenfurt.

Trnova, E., & Trna, J. (2012). Development of science and technology gifted students through inquiry-based science education. In: *Proceedings of the 8th International Conference on Education* (pp. 838-844). Samos, Greece: Research and Training Institute of East Aegean.

THE DISCUSSION AS A METHOD TO TEACH PHYSICS AT THE UNIVERSITY

Louis Trudel
University of Ottawa, Canada
E-mail: ltrudel@uottawa.ca

Abdeljalil Métioui
University of Québec in Montréal, Montréal, Canada
E-mail: metioui.abdeljalil@uqam.ca

Abstract

Physics teaching strategies used in university-based science courses are mainly focused on the so-called traditional teaching, composed of lectures and laboratory exercises. This way of teaching physics does not allow students to acquire understanding of basic notions of physics so that some enduring misconceptions may hinder future learning. Thus, our research aims to identify the conditions of implementation of the discussion method in a physics education course for pre-service teachers. Our results point out three conditions that must be satisfied to implement successfully the discussion method in physics education courses. We conclude by stating advantages and limits of our research.

Key words: *pre-service science teachers, physics education, socio-constructivist approach.*

Introduction

Despite the predilection of science education research for socio-constructivist approaches, teaching strategies used in university-based physics courses are mainly focused on the so-called traditional teaching where the teacher presents the content through lectures, offers students exercises to develop problem solving skills, and brings them to the laboratory to verify the content of the course. This is rather surprising, given the difficulties students have in learning physics at university that these educational strategies seem unable to correct (Viennot, 1992). Their difficulties may also lead them to not pursue further studies in scientific or technical fields (Testard Vaillant, 1992). However, some efforts have been made to renovate university teaching. Among these new ways of teaching, discussion, despite its attractiveness and its potential to facilitate the achievement of various educational goals (Gall and Gall, 1990) is little used. Indeed, Dillon (1995) found that less than 5% of class time is used for discussion. In this regard, the use of the discussion at the university is likely to face several obstacles: different status of the participants, choice of a discussion theme by the professor which does not necessarily interest students, fears expressed by students they may not have the skills to express themselves in a discussion, etc. (Costa, 1990). These problems, if not overcome, can seriously reduce the effectiveness of the method of discussion to foster students' conceptual understanding in physics. Thus, our research aims to clarify the conditions of use of the discussion in physics classes and, from these results, develop guidelines for its use.

Methods

The experimentation took place in different settings. The first place is a faculty of education during a course in physics education for future science teachers. The other settings were four classrooms in two high schools in the province of Quebec, and finally with a group of in-service high school science teachers attending a workshop the principal researcher held on the teaching of various physics concepts. To study the implementation of the teaching strategy described in the precedent section in these three settings, the main researcher who was also the teacher held a diary where he recorded his observations on the sequence of events, his reflections about the observed events, and links between his observations and the theoretical framework of the present research (Altrichter & Holly, 2005). Finally, our point of view is not that of the specialist familiar with the main theories in the field of science education, but of the reflective practitioner, pondering its practice of physics teacher in high school and didactics of physics, inspired by the theories of learning, teaching and assessment to propose possible solutions to issues that arise from the perspective of professional development (Burnaford, Fischer and Hobson, 2001).

Results and Discussion

Following our experimentation in these various settings we have identified three essential conditions for science discussion method that are consistent with other researches in similar areas. The first condition is to foster interdependence between participants and their influence on each other (i.e. reciprocal influence) to reach a common goal (Costa, 1990). Secondly, to promote interdependence among students, it is better to group students by ensuring that their interests and skills are diversified (Gall and Gall, 1990). Finally, it is preferable to propose topics for science discussion, such as phenomena or situations of everyday life that elicit the expression of ideas students if one wishes, on one hand, to diagnose their misconceptions and also to get them to change them (Hazel-Hegarty, 1990). The second condition is to define the roles, behaviours and responsibilities assigned to each participant so that all contribute to the establishment of a discussion that achieves its objectives. In particular, the role of the teacher in the method of discussion is crucial. The teacher must move away from its role as expert to become a leader and a leader. The third condition is to formulate rules about the operation of the discussion method to ensure the participation of all its members and to promote interaction between them.

Conclusions

To conclude, it appears that our study clarifies the role played by certain aspects associated with the implementation of the method of discussion in science courses at University: difficulty experienced by science professors to appropriate the method of discussion, influence of some implementation details to the other components of the method of discussion, interaction between certain contextual features and the course of the discussion. Therefore, our research reveals the complexity of the various sources of influence that can reduce or increase the effectiveness of the method of discussion when used in schools.

References

Altrichter, H., & Hollly, M. L. (2005). Research diaries, In B. Somekh et C. Lewin (Eds.), *Research Methods in the Social Sciences*, chap. 2. Thousand Oaks (Californie): SAGE.

Burnaford, G., Fischer, J., & Hobson, D. (Eds.). (2001). *Teachers doing research: The power of action through inquiry,* 2nd ed., Mahwah (NJ), Lawrence Erlbaum Associates.

Costa, Arthur, L. (1990). Teacher behaviors that promote discussion. In Wilen, W. (Ed.), *Teaching and learning through discussion: The theory, research and practice of the discussion method*, pp. 45-77. Springfield (Illinois): Charles C. Thomas.

Dillon, J. T. (1995). Discussion. In Anderson, L.W. (Ed.), *International Encyclopedia of teaching and Teacher Education*, 2nd ed., pp. 251-255. Toronto: Pergamon Press.

Gall, Joyce, Meredith D. Gall. (1990). Outcomes of the discussion method. In Wilen, W. (Ed.), *Teaching and learning through discussion: The theory, research and practice of the discussion method*, p. 25-44. Springfield (Illinois): Charles C Thomas, Publisher.

Hegarty Hazel, E. (1990). The student laboratory and the science curriculum: An overview. In Hegarty Hazel, E. (Ed.), *The student laboratory and the science curriculum*, pp. 3-26. New York: Routledge.

Prégent, R. (1990). *La préparation d'un cours*. Montréal: Éditions de l'École Polytechnique, 274 p.

Testard Vaillant, P. (1992). L'abstraction sélective. *Science et Vie*, 24-28.

Viennot, L. (1992). Physique: ça résiste. Pourquoi? *Science et Vie*, *180*, 76-83.

INNOVATION SKILL DEVELOPMENT POTENTIAL OF TEACHING PROGRAMMING TO CHILDREN IN THE CONTEXT OF THE STEM EDUCATION

Adem Uzun
Uludag University, Turkey
E-mail: adem.uzun@gmail.com

Abstract

Innovation is one of the most popular topics in today's education environments. STEM education aims to improve innovation skills of students. This study explores three programming tools that can be used to teach basic programming concepts to children in the context of STEM education. Also, it is discussed innovation skill development potential of these tools.

Key words: *education environments, interdisciplinary approach, STEM education*.

Introduction

Today many countries are facing global economic difficulties. Innovation is considered to be a solution to that problem (Organisation for Economic Co-operation and Development [OECD], 2010a). Innovation has product and process dimensions that are directly related with the technology. It is a fact that innovation cannot be guaranteed by success in only one single discipline in today's world. STEM (Science, Technology, Engineering and Mathematics) Education is a result of such an interdisciplinary approach. Technology is a central discipline which has direct links with other disciplines such as science, mathematics and engineering.

Theoretical framework of STEM Education is based on curriculum integration by relating the learning experiences to real life (Corlu, Capraro & Capraro, 2014). It is aimed to help students to become more self-directed, productive and socially interactive problem solvers. STEM Education encompasses the educational attainments that are collaboratively constructed by the intersection of more than one field in science, technology, engineering and mathematics. There are also some barriers about implementing STEM Education. Teacher education system is one of the barriers because teachers usually become experts only in their own discipline after graduation. For instance, a science teacher may not be competent in engineering or a mathematics teacher may be competent in technology.

The developments in software field could be a solution to teachers' incompetency in technology. Today we can find some tools that can be easily used by the teachers. Using these tools, teachers can teach programming to the children without the need of any technology specific knowledge such as programming. These tools can be used in the context of STEM Education easily.

Popular Tools for Teaching Programming to Children

MIT's SCRATCH

Scratch is a free desktop and online multimedia authoring tool. It provides a stepping stone to the more advanced computer programming because one can make programming just dragging and dropping the visual objects in it without writing any codes. Also, it can be used in math and science projects. Scratch helps young people learn to think creatively, reason systematically, and work collaboratively in order to gain essential skills for life in the 21st century (MIT Media Lab, n.d).

Microsoft Small Basic

Small Basic is another tool for children or adults who want to take the first step into the programming world. It requires writing codes, but it eases this process with its user friendly development environment (Microsoft Corporation, n.d.).

Lego Robotics Programming

Lego offers both software and hardware platforms to teach programming. Children build the robot and program it to perform certain tasks. They decide the tasks, use robot's motors, sensors and physical parts, therefore they improve their creativity.

Conclusions

Innovation is one of the most popular topics in today's education environment. Innovation is mostly related with the fields such as science, mathematics, technology and engineering. Therefore, STEM education is becoming more important every day. Since STEM education is based on integrative curriculum, it is hard to implement it in today's educational environments. Technological developments offer a number of opportunities to reduce these difficulties. Programming tools for children are among these opportunities for STEM educators. It is easy to learn and use them for the educators in different fields in the context of STEM education. Also, these tools have the potential to improve children's innovation skills. These skills are very important for STEM education. There are many research studies about the effect of these tools on children's innovation skills (Erdogan, Corlu, & Capparo, 2013; Miglino, Lund, & Cardaci, 1999; Lund, 1999).

References

Corlu, M. S., Capraro, R. M., & Capraro, M. M. (2014). Introducing STEM education: Implications for educating our teachers in the age of innovation. *Education and Science*, *39* (171), 74-85.

Erdogan, N., Corlu, M. S., & Capraro, R. M. (2013). Defining innovation literacy: Do robotics programs help students develop innovation literacy skills. *International Online Journal of Educational Sciences*, *5* (1), 1-9.

Lund, H. H. (1999). AI in children's play with LEGO robots. In: *Proceedings of AAAI 1999 Spring Symposium Series*.

Microsoft Corporation (n.d.). *About Microsoft Small Basic.* Retrieved from https://scratch.mit.edu/about/.

Miglino, O., Lund, H. H., & Cardaci, M. (1999). Robotics as an educational tool. *Journal of Interactive Learning Research*, *10* (1), 25-47.

MIT Media Lab. (n.d.). *Scratch help-About scratch.* Retrieved from https://scratch.mit.edu/about/.

Organisation for Economic Co-operation and Development (2010). *Measuring innovation: A new perspective - online version.* Retrieved from http://www.oecd.org/site/innovationstrategy/measuringinnovationanewperspective-onlineversion.htm

ON VOLUME OF THE ANTIPRISM IN CUBE AS A COMPLEX MATHEMATICAL PROBLEM

Lukáš Vízek
University of Hradec Králové, Czechia
E-mail: lukas.vizek@uhk.cz

Abstract

This paper shows the mathematical task, calculation of the volume of the antiprism in cube as a secondary school mathematical problem, which can help to teach mathematics in the relationship between its parts. The contribution brings the mathematical background, mentions experiences with them as well as visualizations and the possibilities of its completion.

Key words: *antiprism, volume, solid geometry, visualization*.

Introduction

In this text we bring an overview of one mathematical problem. It is an example of secondary school exercise, whereby we can interconnect several parts of school mathematics and also point out the importance of visualization in education for a better understanding of the problems. The task was created by the author of this paper and his mathematical side was in more details described in the work (Vízek, 2015). Here we focus on activities and experiences with them.

Methodology of Research

Our task is: What is the volume of the antiprism, which bases are the triangles and , where means the middle of appropriate edge of a cube (which side is unit)? Generally speaking, we have two basic methods of solving this problem. By the first one we can divide the solid into particular parts, calculate their volumes and summarize them. By the second we can think about cutting some pieces away from the considered cube, calculate their volumes and subtract them from 1 (from the volume of our cube).

First method

Let us divide the antiprism into two same pyramids (see Fig. 1). Their base is the rectangle , where (one half of a face diagonal) and (calculated by the Pythagorean theorem). The height of the pyramid is , it is the distance between the point (or) and the plane. The volume of the pyramid is , so the volume of our antiprism is .

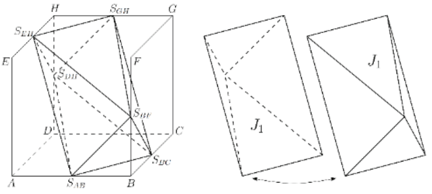


Fig. 1

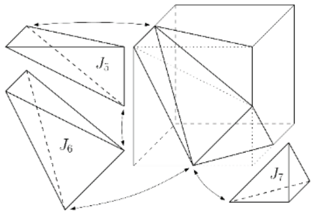


Fig. 2

Second method

On Fig. 2 we can see three basic shapes need to be cut away. All of them are pyramids. The first one from above, has as his base the right triangle with the length of legs and . The height of is also . So the volume is equal to . As the base of the pyramid we consider the isosceles triangle in the front side of our cube (his base is and the height is). The height of is and the volume is. To calculate the volume of the smallest pyramid is trivial, here we get the result . Finally, we have to see, that it is necessary to cut away 6 pyramids, and 2 pyramids. The volume of our antiprism is.

Antiprism in school mathematics

We can briefly compare these two methods. In the first one it is important to have a knowledge of solid geometry. We see as a hard moment there to find the height of the pyramid. On the other hand computations of volumes of, and in the "cutting method" are trivial. But then we need good spatial imagination to decide, how many of these shapes are needed to be removed. In our research we solved the described problem in three different groups last year. We arranged a "special" mathematics lesson at the secondary school Gymnázium Elišky Krásnohorské in Prague. We used our exercise when we needed to sum up and repeat metric problems in solid geometry. Then we gave our task to students of our department at the University of Hradec Králové, who study to be mathematics teachers at a secondary school. They had to analyse the usability of solving techniques for different ages. We also discussed it with teachers in our seminar *Mathematical Curiosities* at *Summer school for mathematics and physics teachers* (Faculty of Mathematics and Physics, Charles University in Prague).

Results of Research

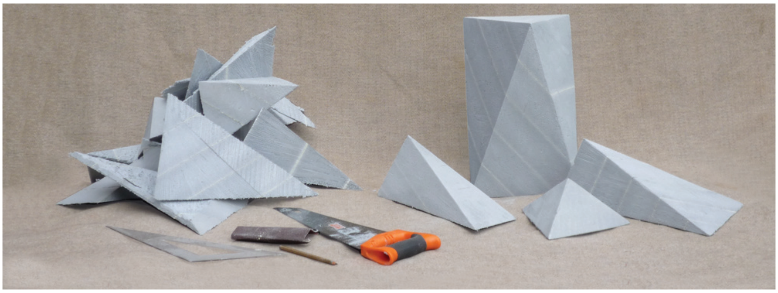


Fig. 5

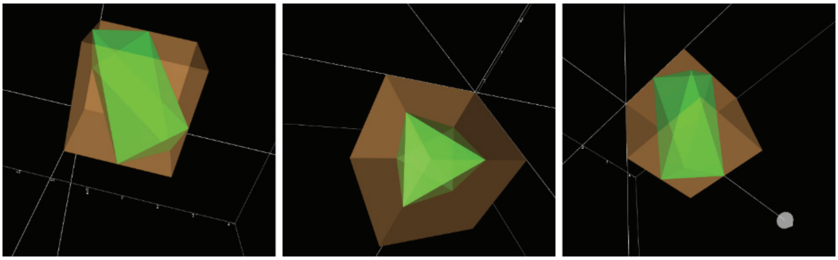


Fig. 4

We have interesting feedback from every group. The exercise was a good motivation for secondary school students, because they normally do not deal with antiprisms (in the past it was different, in an old Czech textbook we can find chapters dedicated to antiprisms, see Šanda, 1870, pp. 301–305). They quickly calculated each volume, because they had skills in solid geometry. But they had problems with the number of pyramids , and in the second method. This we can overcome with "making sculpture" demonstration. On Fig. 3 we can see a helpful model of antiprism with cut off pyramids from extruded polystyrene. With the university students we talked about the possibilities of visualisation of antiprism using dynamic geometry software. Although, it is just a displaying, it is sometimes easier way to show the solid at school. As a good software we used the Autograph in which we can smartly rotate with the model (Fig. 4, for more information about Autograph see ICT Training Centre Oundle, 2015). Our task is mainly a part of solid geometry. But some teachers above mentioned Summer school, calculated some necessary distances using analytic geometry. Well, it is a proper way for example to find the height of the pyramid and it gives our task to another dimension.

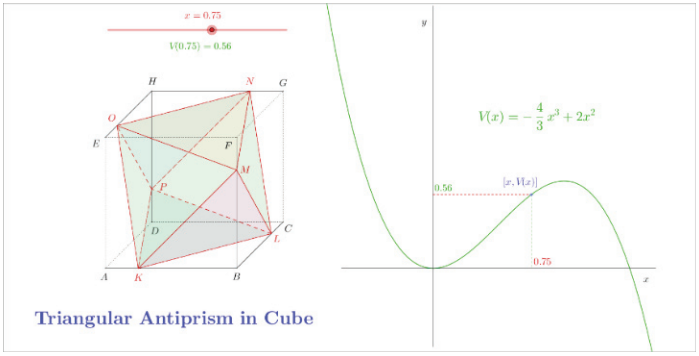


Fig. 5

Conclusions and Implications

The author of this paper prepared a mathematical program of *The Project Day* at the secondary school Gymnázium Bohuslava Balbína in Hradec Králové (November 2015). His seminar will be orientated towards good nontrivial tasks like this one, which are inspiring for finding relations between parts of school mathematics and which have elements of enquiry-based learning.

At this moment we can finish our contribution with the modification of the described task. It is good to think about changing the shape of the antiprism and search the function, which describes the volume depending on the position of vertexes. This question moves the problem to functional analysis and can be properly shown, for example with Geogebra (Fig. 5).

References

iCT Training Centre. (2015). *TSM Resources*. Retrieved April 7, 2015, from http://www.tsm-resources.com

Šanda, F. (1870). *Měřictví pro vyšší třídy středních škol. Díl I*. Prague: I. L. Kober.

Vízek, L. (2015). *Hranolec*. *Učitel matematiky*. In print.

CHEMISTRY OF PAINTINGS OR HOW TO INVOLVE 8-10 Y.O. CHILDREN FOR A TWO-HOUR SESSION WITHOUT BREAKS

Denis M. Zhilin
Polytechnical Museum, Moscow, Russia

Marina Tokareva
Museum of Russian Impressionism, Moscow, Russia

Abstract

The paper describes the experience of sessions on chemistry of paintings and chemistry of pencils for 8-10 y.o. pupils and their parents. The session consisted of lecture on the history of paints and pencils and laboratory sub-session where the participants made paints and pencils themselves. The participants could quit whenever they wanted, but really worked for more than two hours without break, that is extremely long for this age. We think that the reason is a diverse activity and a bright output.

Key words: *chemistry, elementary school, laboratory, painting*.

Scientific laboratories of Polytechnic Museum (Moscow) provide various extracurricular activities on science for children and adolescents. Among them we in collaboration with the Museum of Russian Impressionism have conducted the sessions “Painting and Chemistry” and “Drawing and Chemistry”. They were announced as sessions for 8-13 y.o. with parents. However, in fact the majority of the participants were 8-10 y.o. Parents of some children preferred to be involved in the activity, whereas the other just left their children for us.

We conducted three sessions on “Painting” and one on “Drawing”. However, this experience is very promising and we’d like to share it.

The session consisted of two sub-sessions. The first sub-session was a 40 minutes’ lecture (conducted by an art historian), was a brief overview on the history of paints in the context of history of paintings (or of pencils in the context of the history of drawing) – with many colorful illustrations. The second sub-session was conducted in the laboratory where the children prepared their own paints or pencils. The laboratory sub-session of “Painting” had the following program.

- Basing for paints (looking at wood and paper via binocular)
- Pigments and soluble dyes (looking via binocular and adding water; the particles of pigments can be observed in water)
- Why pigments should be insoluble (placing a knot of pigment and a drop of dye onto a line; pigments tint the line, whereas the solution does not)
- Tinting (compare quartz and titan dioxide – how they tint black surface; titan dioxide is more effective)

- Is pigment enough to paint? (put a pigment onto a surface and blow it off; the conclusion is that pigment doesn't stand on the surface)
- Can water act as a binder? (mix a pigment with water, paint on a paper, dry and rub the colored surface)
- Colophony binder (dissolve colophony in alcohol, mix with a pigment and draw by this mixture on wood or paper; the paint stands on paper and wood both)
- Protein binder (mix gelatin with water, slightly heat, mix it with a pigment and paint)
- Wax encaustic painting (melt wax, mix it with a pigment and draw by means of wooden splints)

Initially we also offered the students to compare viscosity of water and glycerol; to make mixture of glycerol and pigment and make sure that it is smashed; to draw by a mixture of pigment with glue. But we decided to exclude it because it bored children.

The laboratory sub-session of "Painting" had the following program.

- "Basing for paints", "Pigments and soluble dyes" and "Why pigments should be insoluble" were the same as in "Painting".
- Bringing a pigment onto a paper (put some pigment onto a paper and rub it into by a cotton wool; thus a paper can be colored, but fine drawing is impossible)
- How to remove a pigment (by a bread crumb)
- How to fasten a pigment to a paper (by a hairspray)
- Drawing by tin
- Making black pencil and drawing by them (heating wooden splints in a test-tube)
- Pigment with a binder (mixing pigment with guar gum and drying)
- Wax pencil (melt wax, add vaseline and a pigment)
- Grey pencil (mix graphite, water and kaolin and heat it)

At the end of both "Painting" and "Drawing" sessions the pupils could use paints and pencils to draw whatever they want and take it with them.

At both sessions the pupils had written instructions but did not read them – they followed oral step-by-step instructions and demonstrations of the instructor. When parents worked with their children they caught the instructions and then repeated it and looked that the children follow them. Thus their presence was very helpful.

Laboratory sub-session for painting continued 1 hour 10 minutes – 1 hour 15 minutes without any break. After 45-50 we told the pupils that they leave the laboratory whenever they want if are tired. However, only three of 36 participants did it. The other stayed after the program for 10-15 minutes to make their own paints and paint by them. Thus, in total the pupils spent in the laboratory about one hour and a half. Adding 40 minutes lecture before and a break just to change the room and put on the laboratory coats gives more than two hours. At "Drawing" sub-session the pupils spent even more time. After 1 hour 20 minutes we suggested the students to stop the session warning them that we still had not made grey pencil. However only two of 12 pupils quit and the other asked to make a grey pencil. Eventually, the last pupil left the laboratory after 1 hour 50 minutes of the session beginning after insistent requests of his father. Some of the participants asked where to buy pigments and other components. We think that seemingly less interesting "Drawing" session provides more diverse activities, and thus the children are less bored.

That 1.5+ hours that 8-10 y.o. children spent in the laboratory, is much longer time than could be expected for this age. We think that the reason is (a) diverse activity and (b) bright output.

KEYNOTE SPEAKERS

Dr. Paolo Bussotti
Commission for the Publication of the National Edition of Federigo Enriques's Works, Italy

Title: HOW HISTORY OF MATHEMATICS CAN BE USED IN MATHEMATICS EDUCATION TO TEACH DIFFERENTIAL AND INTEGRAL CALCULUS

Prof. dr. Martin Bilek
University of Hradec Králové, Czechia

Title: SYNERGY AND/OR MISMATCH OF REAL AND VIRTUAL ENVIRONMENT IN SCIENCE EDUCATION

Prof. dr. Metka Kordigel-Aberšek
University of Maribor, Slovenia

Title: ONLINE SCIENCE LITERACY – TEACH OR NOT TO TEACH

Prof. dr. Kuohung Huang
National Chiayi University, Taiwan

Title: MOBILE LEARNING AND OUTDOOR SCIENCE EDUCATION: STUDIES OF ZOO FIELD TRIPS

Prof. dr. Liberato Cardellini
Marche Polytechnic University, Ancona, Italy

Title: A STUDY ON SCIENCE EDUCATION IN ITALY

Lamanauskas V., Šlekienė V., Ragulienė L. (Eds.) (2015). *State-of-the-Art and Future Perspectives. Proceedings of the 1st International Baltic Symposium on Science and Technology Education (BalticSTE2015).* The Scientia Socialis Press, Šiauliai.

ISBN: 978-609-95513-2-6

Designer & Paste-up artist	Loreta Šimutytė-Balčiūnienė
English language proofreader	Ilona Ratkevičienė

10 June 2015. Publishing in Quires 7. Edition 200.

Publisher
Scientia Socialis
29 K. Donelaičio Street,
LT-78115 Šiauliai, Lithuania
E-mail: scientia@scientiasocialis.lt
Website: http://www.scientiasocialis.lt/

Printing
Joint-stock company „Šiaulių spaustuvė“
9A P. Lukšio Street
LT-76207 Šiauliai, Lithuania
Phone: +370 41 500 333.
Fax: +370 41 500 336
E-mail: info@dailu.lt

ISBN 978-609-95513-2-6

© Scientia Socialis, UAB, 2015